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Change of Address

ON May 1 the offices of the Aldrich Publishing Company, publishers of MARINE ENGINEERING and THE BOILER MAKER, were moved from 17 Battery Place to the new Printing Crafts Building, 461 Eighth avenue, New York city. Hereafter all communications to the American office of MARINE ENGINEERING should be directed to the new address.

The Printing Crafts Building, which is to be the future home of MARINE ENGINEERING, is a new twenty-two story structure especially designed to meet the needs of the printing and publishing trades. It occupies the block between Thirty-third and Thirty-fourth streets, facing Eighth avenue, adjacent to the Pennsylvania Railroad Terminal and directly across the street from the main New York Post Office. Every facility for the prompt and rapid execution of printing and publishing contracts has been incorporated in the new building and a cordial invitation is extended to all of our patrons to visit and inspect our new quarters.

Analyzing a Marine Steam Plant

NOT every marine engine is properly designed or properly adjusted, nor is every marine engine supplied with steam at the most suitable pressure for its economical operation. Again, it will be found that many marine engines are driving poorly designed propellers. In fact, all the way from coal bunkers to the propeller there are innumerable opportunities for losses in economy in generating and transmitting power, which may have been caused by poor design, faulty construction or the lack of necessary auxiliary apparatus. Such conditions must be faced by marine engineers, who are in no way responsible for them, but who must be able to find out why the owner of the vessel is not getting a reasonable return in power from the coal he is supplying for the operation of the vessel.

To determine the exact cause of the loss of the economy in a marine steam plant requires a careful analysis of the plant as a whole. That this task is not beyond the reach of the average engineer is shown by the instructive letters which are being contributed to this magazine each month by practical engineers who have faced and solved such problems. These letters tell how to combine indicator cards, and how to study the combined diagrams, comparing the theoretical curves with the results actually obtained. Methods of checking up the various credits and debits of heat in a marine plant are explained in simple language without the use of higher mathematics. It is not uncommon to find from such an analysis that the steam pressure, expansion ratio and condenser are utterly out of harmony. With such an analysis, however, if carefully and intelligently made, it should be possible for a competent engineer to locate definitely any trouble which hitherto may have appeared to be mysterious.

The ability of an engineer who is placed in charge of the engine room of a steam vessel, whether it be a tug boat or an ocean liner, to size up the imperfections in the steam plant and determine the possibilities of improvements which will result in actual savings in fuel consumption and reductions in the cost of operation of the vessel, will have an important bearing upon the future relationship between the engineer and his employer and upon the advancement and promotion of the engineer. Such ability is not an inborn characteristic of an engineer, but it is gained by experience and study, and to those who are ambitious to improve their standing and become masters of their profession we recommend a careful study and investigation of this important subject in all its phases.

Training of Officers for the Merchant Marine

TO provide facilities for educating and training young men to become deck and engineer officers in the American merchant marine a bill has been introduced in Congress authorizing the establishment and maintenance of two training schools, one on the Atlantic coast and one on the Pacific coast, for marine cadets. According to the provisions of the bill young men who have had at least six months' training as naval apprentice seamen or two years at sea in the merchant marine will be eligible as candidates for appointment as marine cadets. Appointments will be made in the order of merit as shown by a competitive examination, and they will be made only on condition that the applicant will obligate himself to serve on vessels of the merchant marine or army transport service or in the naval auxiliary for five years subsequent to the date of his graduation, and also that he will enlist in the naval reserve forces of the United States for two successive periods of four years each. The number of cadets appointed each year is limited at first to one hundred and twenty-five, of whom fifty shall have served as apprentice seamen in the navy. The course of instruction and training proposed is to continue for a period of two years and upon completion of the prescribed course the cadet will be entitled to receive the lowest grade of license required by law on ocean-going steamers for deck or engineering duties, as the case may be. It is proposed that the schools shall be conducted by the Coast Guard Service on vessels furnished by the Secretary of the Navy, and that each cadet shall receive an annual allowance of $500 (£103).

The lack of facilities for training officers for the merchant marine is apparent when it is remembered that only two states in the country maintain schoolships for this purpose. Competent officers for the rapidly increasing merchant marine must be provided and the benefits of-

fered by this bill should appeal to every patriotic American.

The two States which maintain schoolships are New York and Massachusetts. Prior to 1913 the New York schoolship was directed by the Board of Education of the city of New York, but since that date it has been under the jurisdiction of the State, and men are admitted to the school from the Great Lakes region as well as from the Atlantic coast. These facilities, however, are far too limited to meet the needs of the rapidly growing merchant marine, and national schools adequately equipped under the direction of the Coast Guard Service or Navy Department should be provided for both the Atlantic and Pacific coasts.

Profits from Old Vessels

BY M. WOOLLEY

A veteran master mariner who has sailed the seven seas had this to say one day before the European war began:

"American clipper ships used to pay for themselves in a single voyage when the American merchant marine was in its glory. My own clipper, which cost a small fortune, repaid her cost to her owners in a single trip to the Philippines. That time will never be seen again. It is gone forever!"

But how mistaken was this sorrowful old salt, now relegated to retirement ashore. Blockades and submarine campaigns and the demands of war have made the world short of ships. Ghouls have gone into ship cemeteries and exhumed the remains of many an old "tea-kettle" and many an old sailing vessel to get the world's goods going again. Exhuming marine mummies is now the sport of shipping firms, and superannuated ships are worth not only twice what they originally cost, but they likewise will repay for themselves on almost every trip for some time to come.

We Americans, regardless of what legislation in the immediate future is likely to bring us, are about to find ourselves equipped with a merchant marine almost over night. We are not waiting for them to be built. We are digging up dead ships and sending their ghosts flitting across seas, taking coasters off their shore-line routes and sending them broadcast, and taking unprofitable bottoms out of pawn to put them in a service where carriage prices are bound to bring a return worth while.

Within one week this spring nearly a score of coast steamers were taken off their routes on the Pacific and placed in the overseas trade with China and Japan. These boats all go loaded to the superstructure. Charter parties, still soaring, have reached unprecedented figures. Prices are responsible for this remarkable transition. Any craft which is sufficiently seaworthy to pass the inspectors gets a new lease of life, and possibly the inspectors wink at many a slight defect.

Especially is this an era when the decaying windjammer returns to power. The kings of old are returning to their thrones and claiming their crowns as common carriers. Sailing ships which have been lying in boneyards for years and which it was once believed would never again feel the heave of the open sea, have been rejuvenated and returned to a road on the trackless ocean.

Many steamers have likewise entered on new and extended careers. For instance, the *City of Pueblo,* which for years has done nothing but coast between Pacific ports, is now in the Far East trade. Her first voyage to Hong Kong, Kobe and Yokohama netted the owners a handsome profit, probably nearly as much as the steamer is worth. Many of this old-time ship's colleagues have also taken to deep water in their old age, so that now they pass one another in mid-Pacific instead of off shore from Oregon, Washington or California.

Ships which have never felt the fury of a typhoon or the seductiveness of a trade wind, and which have never ventured so far from home as to cross an ocean, are now plowing their way back and forth between China and Japan and the United States. What we want to do is to get these makeshift carriers started into the South American trade until we can get a host of new ships, operating under favorable laws, into the field.

At the fabulous rate of $20,000 (£4,100) per month, the American steamer *Edna* has been fixed on time charter for a year in the Atlantic coast trade. Just listen to this: The charter will bring this ship's owners the princely sum of $240,000 (£49,200). This amount will build a dream of a freighter, and probably two ships like the *Edna.* Likewise some old ships are being sold for sums far and away more than they cost. An American ship was sold the other day to the Japanese for $1,000,000 (£205,000), and new it probably cost less than half that sum.

Here is another startling instance of the value of old and decrepit sea craft, one which should make us all wish we had an old tub of some sort peacefully reposing in the backyard, but not too far away from the lashing waves: The steamer *Dunholme* has been sold to an oil company to help relieve transatlantic traffic, for $850,000 (£174,000), or nearly one million dollars. Four years ago the hulk of the *Dunholme* was sold, according to report, for $30,000 (£6,150), after a fire, which burned away only her superstructure and interior fittings. The *Dunholme* is capable of carrying but 5,500 tons.

If the demands keep growing it will soon pay the owners of small fishing smacks, and even motor boats, to charter for deep-sea service. Pacific coast purchasers of Great Lake steamers to be brought west via the canal or the Horn were recently offered attractive charter rates. One purchaser was offered $240,000 (£49,200) per year for his two boats, making a total of $480,000 (£98,400). But he figured he could do better himself on the Pacific. Others similarly situated were offered charters equally as attractive, but in almost every instance declined them.

The ships purchased on the Great Lakes were for the Alaskan service, mostly between Seattle and Alaskan way ports. This field or route now has the largest fleet of coast steamers in service anywhere in America, and it is constantly growing. As many of these ships are, however, suitable for ocean-going trade, they may be withdrawn for a time and sent into the deep-sea trade. Our next biggest lot of American bottoms is in the fruit trade. Banana trade with the Central and South American countries engages more American steamers flying our own flag than any other shipping business having a foreign end. This, with the Great Lakes traffic, is about the biggest lot of ships we have engaged in marine movements anywhere.

Oriental commerce is growing by millions. It is climbing up by leaps and bounds. The prognostication of statesmen that the Pacific is "the eye of the world" is proving true. The January carrying business between Seattle and Far Eastern ports was the greatest by far on record. There are five miles of switches at Seattle laden with cars of freight awaiting steamers to cross the Pacific. It has been necessary to empty the contents of many cars alongside the tracks so that Eastern rail shipments may not be congested for want of cars.

A Japanese firm recently bought the American steamer *Mackinaw,* paying three times as much as was paid for her when bought by Americans eight months ago. To be exact, the Japanese paid $300,000 (£61,500), while the

American owners paid but $100,000 (£20,500). A fleet of four old schooners, considered junk not many moons since, were recently sold for a total of $104,000 (£21,300).

The Philippine Islands fear a withdrawal of their own inter-island steamers for use elsewhere throughout the world. Already Philippine industry has been hurt by the loss of several Chinese ships withdrawn for over-ocean carrying. Philippine inter-island ships have made several trips to the United States for the first time probably in history, and matters are so serious in business circles in Manila that the Government has ordered the army transports to carry freight to and from the islands.

Calls for sales or charters of ships are coming into the shipping offices of the Pacific by telephone, telegraph and by mail. Shipping offices everywhere are taking on activities similar to those in rich mining camps.

But, let us hope that superannuated steamers and rejuvenated ships will save the day for us until we can replace them with the best and biggest ships in the world.

Freight Handling at Marine Terminals

BY A. JACKSON MARSHALL*

The costly congestion of freight at railroad and steamship terminals has reached such proportions that before long remedies will of necessity have to be evolved. A study of the problem would indicate that railroads and steamships are carrying freight most efficiently between points, but the handling of merchandise to and from and in the terminals leaves much to be desired.

It therefore appears that changes will have to be effected in the transportation of freight to and from the terminals and in the handling of merchandise in the terminals themselves. While great improvements have been made, much more could be effected in these two phases of local freight handling. It seems to the writer that the full measure of possible success can only be obtained when the local transportation and the handling of freight in the terminals are considered jointly, instead of as two separate and distinct phases. No matter how perfectly developed the method of freight handling in terminals may be, the highest efficiency cannot be obtained unless the movement of freight to and from terminals by trucks be such as will exactly fit into the scheme of terminal operation and vice versa.

It is apparent that the local transportation of freight is unsystematic and very costly. It is hardly necessary to review the chaotic conditions existing in this branch of the work, which seem to get worse instead of better. Almost everyone is familiar with the losses resulting from the influx and outflow of freight during certain hours of the day at the terminals and the inactivity at other periods, due to the fact that nearly everyone wants service at the same time, which is a physical impossibility to render. The thousands of trucks compelled to wait their turn pile up a loss that is counted in the tens of millions.

If each truck had a definite time to call for or deliver merchandise to the terminals and the schedules were observed, the terminals, perhaps, operating at night as well as day, delays and losses due to congestion would be reduced to a minimum. Furthermore, trucks and trailers could systematically operate better at night, since they would not be compelled to constantly buck street traffic, with attending delays and accidents. Sooner or later the growing traffic of our cities will force the use of streets at night. There is hardly more reason why the streets of our cities should not be used at night, especially for the transportation of freight, than there would be to confine the use of railroad tracks to day traffic.

If the existing trucking individuals and concerns could get together and work out a method of systematically cooperating in the development of a scientific schedule of operation much could be accomplished. Otherwise, it appears that the railroads must either go into the delivery of freight direct from shipper to consignee, or that large and efficient local transportation companies will have to be formed to sympathetically work with the railroads in the elimination of freight congestion with its attending losses. No matter what method or methods may be employed, action, and prompt action, is imperative.

The more thought the writer gives to the subject the more it appears that organizations possessing the qualifications of efficient express companies would prove to be the solution, for such organizations would have an intimate and practical knowledge of railroading, would understand the receipt and dispatch of merchandise through terminals, have national and international organizations and the connections necessary to the forwarding of freight, and know the local transportation phase of the work. Furthermore, such a development would not be in the nature of an entirely untried experiment, for the transference of express is not so unlike the handling of freight, except that the latter is somewhat more bulky and usually does not move so rapidly. But it is the writer's personal opinion that the costly congestion of freight could be materially eliminated, and far-reaching economies effected if organizations similar to express companies would go into the business of express freight, possibly operating their own terminals and fleets of motor trucks for local transportation, operating along the same general lines employed in the handling of express.

The idea of national organizations competent to handle the freight business much on the same basis as express has been handled seems to be such a simple solution of the problem that the writer has hesitated heretofore to give public expression to it, fearing that it possessed a weak spot unknown to him which possibly prevented others better informed from having expressed the thought before. However, the idea is advanced for whatever value it may have, and if it is not feasible the fact will shortly be known. The details incident to such a development could be worked out if the main thought is acceptable.

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Corresponding Conditions of Steamhip Service

BY ARTHUR R. LIDDELL

Suitability of sizes and speeds of vessels for particular services is a very relative conception, and developments in various directions may entirely alter the circumstances of any given case. But an existing general scheme of dimensions and speeds corresponding with shorter and longer voyages can readily be adapted to new departures of different kinds, and will always serve as a model for tables intended to meet special conditions.

A ship of, say, 100 feet in length, 20 feet in breadth, and 10 feet minimum sea draft, may be assumed to be suitable for voyages of a certain distance when steaming at a speed 6½ knots, and thereby to burn a certain weight of coal and carry a certain deadweight of cargo. What are the corresponding conditions for a vessel of, say, four times or any other multiple of her length?

In general this will depend on the following considerations: The corresponding lengths of voyage for two vessels under comparison will be somewhat in proportion to

the lengths of these. There is a general tendency for the breadths and ballast drafts of vessels to vary as the square roots of the lengths, so that the displacements vary as the squares and the areas of wetted surface as the 1.5th powers of the lengths. This depends on the not yet accepted principles of wave formation, relation of wave length to wave height, etc. Meanwhile the wave height may, for practical purposes, be taken to vary as the square root of the wave length. The speeds of vessels of a given class—say of cargo carriers—tend to vary as the square roots of the lengths, and therefore the horspowers might be expected to vary as $L^{1.5} \times V^3$, where L represents the length of the vessel in feet and V her speed in knots, or, since V varies as $\sqrt{L}$, as L^3. In reality, however, increase of draft gives better propulsion, and the horsepower varies more nearly as $L^{2.5}$. The bunker coal required for the corresponding voyages may vary as $L \times I.H.P. \div V$, or as L^3, the weight of cargo, machinery, and coal as the displacement; i. e., as L^2, and the time spent on the voyage as $L \div \sqrt{L}$, or as $\sqrt{L}$.

To avoid side issues, the proportion borne by weight of machinery to indicated horsepower and the weight of coal burned per indicated horsepower per hour are taken as constant, and the resistance is assumed to depend only on the area of the wetted surface and the speed. Further, the fineness of ends of the vessels are taken to be similar, as are also the types of the vessels and the proportionate lengths of deck erections, while the retardation of speed on account of bad weather is taken to be the same in degree in all cases. Breadth, depth and draft are taken as bearing the ordinary proportions to the length for the different sizes. Table A shows the lines along which the different conditions relating to vessels and their voyages tend to develop, with alterations of size, and the powers of the length L, with which the different positions vary. The system may be applied to the expansion of a vessel, the particulars of which are known, in the following manner:

In the first place the actual data of the model vessel must be used as a basis instead of those in the table. For the not very great variations in size that will usually come in question, a variation of the different positions in relation to the powers of L that govern them (see lower line of Table A) will give sufficiently correct results, provided breadth and draft be each made to vary with $\sqrt{L}$ and the freeboards be those laid down by the International Commission or be in proportion to them. For designing purposes, the conditions must be given or must be worked out for a vessel of approximately the length desired. If carrying capacity or speed be insufficient or too great, the various proportions must be increased or diminished according to the powers of the length L, given at the foot of Table A.

It will be observed that the powers of the dimensions with which the values in the table are made to vary are not in all cases those commonly employed. The reason of this is that breadth and draft tend to vary, not with the length, but with its square root. When a vessel is to be propelled at a higher speed than a standard one of the same dimensions, the ordinary rules of comparison should be applied in making the necessary alterations. Thus, for relatively higher or lower speeds for a given length, the indicated horsepower must be varied in the first place in proportion to the cube of the speed in knots, and in the second with due regard to the number of speed-wave lengths in the length of the vessel; i. e., to the favorable or unfavorable positions of the humps on the speed-power curve. For variations in the proportion borne by length to $(\text{knots})^2$, the variations in the indicated horsepower required for given speeds depend on too many factors to admit of their being taken into account by a simple formula. For faster vessels than cargo boats, proportions borne by length to $(\text{knots})^2$ of 1 : 0.7, 1 : 1.27, and 1 : 1.83, respectively, have been stated on good authority to be favorable to speed, while those of 1 : 0.42, 1 : 0.98, and 1 : 1.55 were stated to be unfavorable.

For cargo vessels of average fullness of ends, the row of favorable proportions may perhaps be extended by 1 : 2.39 and 1 : 2.95, and that of unfavorable ones by 1 : 2.11 and 1 : 2.67.

Though the advantages and disadvantages as regards propulsive efficiency are not so great in these relatively slower vessels, instances have been known in which lengthened vessels have steamed at their former speeds with considerably less horsepower. If speed be the basis of a new

TABLE A.—SHOWING CORRESPONDING CONDITIONS OF STEAMSHIP SERVICES FOR VARIATIONS IN LENGTH OF VESSEL

Dimensions of Vessel.										
Length (L) Feet.	Breadth Feet.	Ballast Draft, Feet.	$\sqrt{\text{Length.}}$	Speed.	Distance Run.	Coal Required.	Indicated Horse-power.	Weight of Machinery Cargo and Coal.	Duration of Voyage.	Displace-ment.
Feet.	Feet.	Feet.		Knots.	Knots.	Tons.		Tons.	Days.	Tons.
100	20	10	10	6½	500	12	150	200	3.2	600
225	30	15	15	9¾	1,125	137	1,150	1,010	4.8	3,037
400	40	20	20	13	2,000	768	4,800	3,200	6.4	9,600
625	50	25	25	16¼	3,125	2,930	14,650	7,810	8.0	23,437
(900)	(60)	(30)	(30)	(19½)	(4,500)	(8,748)	(36,450)	(16,200)	(9.6)	(48,600)
			Powers of $\sqrt{L}$	L with which the values in the different columns vary.						
				$\sqrt{L}$	L	L^3	$L^{2.5}$	L^2	$\sqrt{L}$	L^2

TABLE B.—SHOWING PROPORTIONATE WEIGHTS OF MACHINERY, COAL, AND CARGO FOR VARIATIONS IN LENGTH OF VESSEL

Length.	Displacement.	Weight of				
		Machinery, Coal, and Cargo.	Machinery.	Coal.	Machinery and Coal.	Cargo, Exclusive of Coal.
Feet.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
100	600	400	30	12	42	558
225	3,037	2,024	230	137	367	2,670
400	9,600	6,400	960	768	1,728	7,872
625	23,437	15,625	2,930	2,930	5,860	17,577
(900)	(48,600)	(32,004)	(7,290)	(8,748)	(16,038)	(32,562)

design, it may be of advantage to choose a length that will give favorable conditions. For existing vessels there may be speeds, less than the extreme ones, at which propulsion is more economical. That deep immersion is conducive to good propulsive effect is well known. The ballast or minimum sea draft of a steamer is commonly about equal to the square root of her length. This is a fairly good standard of comparison, whether or no a little more or a little less draft be considered suitable.

Tables A and B contain approximate values that are not to be taken literally. The tables may be enlarged by interpolation to any desired extent, and for application to given conditions it will be advisable to vary the figures in accordance with data obtained from vessels on the services in question. As they are, they give general indication of the changes which accompany increase of size and of distance run.

Inclining Experiments—Practical Hints

BY L. A. BAIER, B. SC.*

Almost all works on theoretical naval architecture devote some space to a description of the inclining experiment carried out on many vessels to determine the metacentric height, known as GM; or what it really amounts to, the vertical position of the center of gravity of the ship in various definite conditions. However, all such articles coming under the writer's attention have been confined to a discussion of the theory involved, with only a brief outline of the actual experiment itself. It is the intention of this article, therefore, to omit any detailed review of the familiar theory involved and to describe the practical methods of carrying out this experiment. Now

$$GM = \frac{w \times d}{\Delta \times \tan \Theta},$$

where GM = required metacentric height in feet,
w = weight in long tons required to list the vessel through an angle of Θ degrees,
d = distance in feet through which w is moved in order to produce a list of Θ degrees,
Δ = total displacement of vessel in long tons at the time of the experiment.

It can be readily seen, then, that in order to obtain the GM of a vessel we shall have to place a certain weight on board, move that weight through a measured horizontal distance, and determine the angle of list produced. This list may be either longitudinal or transverse. With the exception of submarines, vessels are only inclined transversely, and that is the phase we will keep in mind in the following description. We will now take up the successive steps to be followed both in the preparations and in the experiment itself.

Preparations

The first essential is to determine approximately the amount of weight that will be required, or the value of w in the formula. This weight is made up usually of pigs of iron running from 50 to 125 pounds per pig.

From the previous equation we find that

$$w = \frac{GM \times \Delta \times \tan \Theta}{d}.$$

We can determine very closely about what Δ, the displacement, will be at the time set for the experiment, by reading the present drafts of the vessel, referring to the displacement curve and correcting for any future additions or subtractions of weights.

The value of Θ is usually taken at from 2½ to 3 degrees. d, the distance through which the weight is to be moved, is determined by the available beam of the vessel. This distance should be kept as large as possible, as the greater length of d we can use the less weight is required for the same list.

The remaining factor in this preliminary estimate of w is GM, which may be taken at about the value expected as calculated from the estimated heights of the centers of gravity and from other design data. This is the factor which may lead us astray in our estimate, especially in the case of old vessels where we have no definite data, and in the case of vessels in an uncompleted state. We shall shortly show how to check this factor when loading the pig on board ships.

The following data are taken from an experiment recently carried out by the writer on a United States naval vessel under construction at the Seattle Construction & Dry Dock Company's plant at Seattle, Wash.

In this case

$$\Theta = 2\tfrac{1}{2} \text{ degrees and } \tan \Theta = 0.043661.$$

The beam of the vessel was 45 feet 6 inches, giving an available travel athwartship of about 40 feet. The GM expected was about 30 inches, or 2.5 feet. The displacement, after all allowances were made, was estimated to be 2,250 tons. Then

$$w = \frac{2.5 \times 2{,}250 \times 0.043661}{40} = 6.15 \text{ tons.}$$

The customary, and really only accurate, method is to start the experiment with the vessel upright. Therefore we shall need 12.3 tons altogether—6.15 tons on each side. An order is now issued to the foundry or storekeeper to weigh up and deliver alongside the vessel on the day previous to the date set for the experiment this amount of pig. Each pig should have its weight plainly marked on in with white paint and the total load should be delivered, when possible, on a small hand car, to facilitate the crane loading it on board ship.

Preparing the Vessel

The next step is to prepare the vessel. The exact location of the weights on the ship depends, of course, on the type of vessel and deck arrangements. Rough cribs should always be used to contain the pigs, as the centers of gravity of the weights are then easily determined and can be kept in certain positions, and the decks, bulwarks, sides of deck houses, etc., are protected.

These cribs are made of rough two-by-fours and should be divided into two separate compartments. In the case of a tug, for example, two of these double cribs would be made of such dimensions as to allow placing on deck amidships between the bulwarks and deck houses, one to port and the other to starboard. The volume needed in a crib for pig iron runs about 250 to 300 pounds per cubic foot. Note should be taken of the average lengths of the pigs and the cribs dimensioned, to insure the most compact loading. The cribs should be placed, in the case of a tug, amidships opposite or near to a thwartship passageway, so that the pig can be easily carried from one side to the other.

Arrangement of Cribs

The following description of the arrangement of the cribs on the United States vessel referred to above may prove of value, as this method, when applicable, effects a great saving in time and in the number of men necessary for the experiment.

The vessel was so arranged that there was a clear passageway through the middle deck house, with doorways about 9 feet wide on either side. Two double cribs 8 feet

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by 3 feet by 2 feet were placed on deck opposite these doors, one to port and the other to starboard. A temporary track was then built across the ship from crib to crib and blocked up level so as to clear the door sill or coaming plate. A small, flat car was roughly built to fit this track, for the purpose of carrying the pigs from one crib to the other when required. After the pig was transferred the car was always placed on the centerline of the vessel while the readings were being taken. By this means only four men were required to move the weights.

On this vessel two angles of heel were required, so a similar arrangement of cribs and track was constructed on the second deck directly under those on the main deck. These cribs, cars and track should, of course, be saved, and can be used in a large number of cases and the expense of carrying out an inclining experiment by this method will be found to be materially reduced.

"A Place for Everything and Everything in its Place"

The next step is to have the vessel cleaned up. All scaffolding and dunnage should be put ashore or piled up in such a manner and location that its weight and the position of its center of gravity can be easily determined. Port lights and all doors should be closed. All lockers or movable furniture, etc., should be located in their proper positions. Hold battens should be in place, tool boxes and benches put ashore, and every effort made to get off the vessel all possible articles not permanently belonging there and to have all equipment, etc., on board in its proper location.

A careful inspection of all tanks should be made. If the vessel has a list or excessive trim, the proper tanks must be *filled* to correct this. Care should be taken that all tanks, boilers, double bottoms, etc., are either completely filled or entirely empty, to eliminate any free water or oil surfaces.

The ideal case of no free liquid surface cannot always be reached, but this is the result to strive for. The following point is often overlooked in correcting the *GM* obtained from the experiment for free liquid surface. The metacentric height is reduced by $\frac{Pi}{V}$ and not by $\frac{i}{V}$, where

P = specific gravity of the liquid compared with that of the water in which the vessel is floating.

i = sum of all the moments of inertia of the free liquid surfaces in feet and about their own longitudinal neutral axis. Where there are no longitudinal watertight bulkheads this practically coincides with the longitudinal centerline of the ship.

V = total volume of displacement of the vessel in cubic feet.

Just previous to the experiment all air hose lines and steam or water connections should be put ashore.

Location of the Plumb Bobs

The location of the plumb bobs should next be arranged for. These plumbs consist of a four- or five-pound weight attached to the end of a length of fine steel wire, and hung at the other end in such a manner as to allow free swinging of the weight athwartships.

Two rigs are generally used, one forward and the other aft. On small vessels these plumb bobs are usually hung from a light support 10 or 12 feet high erected on the deck at the centerline. The weight should be allowed to hang in a bucket of oil as a damper. Water is sometimes used, but has not very much effect in reducing the vibration of the bob.

The most convenient way of measuring the swing of the wire is to construct a small flat scale, say 24 to 30 inches long, laid off in inches and tenths both ways from a center mark 0. When ready to begin the experiment, all men on board take their proper locations marked on the centerline with chalk. The scale is then clamped to the plumb bob support just above the pail of oil and adjusted so that the wire just hangs over the 0 mark, and so that it is perpendicular to the wire. Then all readings of the swing of the wire either to port or starboard can be read off directly.

In large vessels the plumbs can usually be hung through hatches and the scale clamped to a small support located in the hold. The length of bob should be as great as convenient. The tangent of the angle through which the vessel lists is then the reading of the scale in inches divided by the length of the wire in inches from the point of support to the scale.

The centerline of the vessel in the vicinity of the cribs, and the location of the midship section or the heel of a known frame near the midship section, should be center-punched and chalk-lined in before the experiment is started. The positions of the centers of gravity of the cribs, track, car, observers, etc., can then be located from these marks for future reference in working up the results.

We are now ready to begin loading the weights on board. Knowing the tangent of the angle of heel desired and the length of the plumb wire, we can compute approximately what the reading of the scale should be. Before loading the pig iron on board, the scale should be temporarily clamped at 0. A man with a comptometer can then keep tally of the amount of weight carried on board.

The first load, say 6.15 tons, should be placed in one compartment of the double crib nearest the dock. The comptometer will show the total weight on board at all times, and by noting whether the swing of the bob reaches the reading expected a check can thus be had of the actual amount of the pig required. An overestimate of the *GM* expected would now be shown up by the bob falling short of the required reading, and vice versa.

Additional pig iron can now be put on board or taken off, as is required to list the vessel to approximately the angle required. If, for example, the forward compartment of the port crib has been filled first with the 6.15 tons, then the after compartment of the starboard crib should be filled with the other 6.15 tons to balance the effect on trim.

Precautions in Mooring the Vessel

Just prior to the experiment the vessel should be moored head or stern into the wind by a single line fore and aft and kept entirely free from the dock or any floats, etc. Although there may not be enough wind at the beginning of an experiment to justify swinging a vessel, this factor should be carefully watched, as a slight breeze blowing against the masts and rigging will materially affect the readings at the scale. A skiff should be kept at hand for use in reading the drafts and taking the density and temperature of the water.

The men who are to assist in the experiment should be instructed beforehand as to their individual duties. As noted before, during each reading the men should always return to their assigned positions on the centerline, especially when on board small vessels.

Experience has shown that one of the big assets insuring the successful carrying out of any experiment is the preparation of blank forms for recording the observed data. Too much stress can not be laid on this point. In

preparing these blanks all the conditions liable to arise are more easily anticipated, and in the use of the forms a logical sequence and arrangement of facts are obtained, the data are much more clearly recorded, and there is not so great chance of neglecting to note all the facts or data required.

The Experiment Proper

A brief summary of the successive steps in carrying out the experiment will now be given:

1. A final survey of the vessel should be made to check the condition.

2. All the men required for the experiment should now be taken on board, the gangway removed and the vessel moored free, as described above.

3. By means of the skiff the drafts forward and aft can be taken and at the same time the temperature and density of the water can be observed. A hydrometer is generally used to measure the density of the water.

4. The vessel can now be heeled by transferring the pig from one crib across the ship to the empty compartment of the other crib. After heeling to one side the weight can be brought back and the 0 position of the bobs checked, and then the vessel heeled in the opposite direction.

5. Immediately after the experiment a record should be made of the condition of the vessel, noting the weight and position of the center of gravity of all the foreign weights on board and of the weights still to come on board to complete the vessel. The condition of all the tanks, boilers, condensers, etc., should be noted as to the amount of liquid contained and the extent of free surface, if any. The condition of the bunkers should be recorded.

The method of ascertaining the value of *GM* from the experiment and extending the results for various conditions of the vessel are, of course, familiar operations.

Aside from satisfying guarantees of certain values of *GM*, the results of an inclining experiment are of value to the builder for future designs, and every effort should be made to insure the experiment being carried out accurately and the results intelligently worked up.

Ocean Freighters*

BY ERNEST H. RIGGS †

Ocean freighters can be divided into two main divisions, cargo liners and tramps; the first division can be further divided into types such as oil carriers, bulk freighters, general freighters, refrigerator ships. Freight liners are subject to very much the same rules as passenger liners. Each service develops and improves its own type, whereas in tramps the tendency to standardization can be noted.

This standardization is natural when the circumstances are considered; the ships are to be generally useful, the larger the ship the more cheaply the freight is carried, but harbor depths, wharves, etc., in the smaller ports soon limit sizes, and thus we are forced to a compromise, which can be called a 7,000 ton deadweight carrier, 22 feet 6 inches draft, and of about 360 feet by 50 feet by 29 feet 6 inches molded dimensions.

Statistics give the following average dimensions for cargo vessels:

Item	Year 1890	Year 1900	Year 1910
Length in feet	285	312	340
Breadth in feet	37	41½	46
Draft in feet	19¼	20½	21½

The advance in dimensions is steady and without doubt will so continue; dredging operations continue the world over, and all harbor authorities are anxious to provide the best facilities. It is safe to say that the shipbuilder can easily keep pace with terminal improvements, and in many cases ships have been built with a margin of 2 to 3 feet in their loading ability, in order to be ready to take advantage of port improvements not completed at the time of building.

Single Deck Cargo Steamer.

Turning more particularly to types, one which has been developed to a great extent recently is the single deck cargo steamer. Pillars and hold beams are now eliminated entirely, if desired, from all cargo spaces; arches, transverse and longitudinal, carry the deck and tie the structure together. Single deckers up to 34 feet 6 inches molded depth are being built to receive the highest class. Needless to say, the side framing is getting up to 15-inch channels for such ships. Another comparatively modern idea is in constructing double bottoms with a solid plate floor on every third frame only except at the ends and under machinery.

The omission of all side stringers also should be noted, compensation for which is readily made. In vessels of great depth it is scarcely advisable to fit no stringers on account of the danger of the frames tripping, but the classification tabular number can well be reduced.

Joggling frames and beams are now very general; flush decks made by joggling down the beams and fitting joggled plating are much cheaper than flush decks with planed and fitted edge laps, equally efficient for trucking, and better from the riveting and structural point of view.

Twin masts and king posts are a modern development to be noted. Shorter booms and better working conditions generally result where they are adopted.

Wide spaced framing is adopted in many ships—i. e., the rule spacing laid down by the classification societies is frequently increased several inches. Frames and shell have to be strengthened, of course, and no saving in weight results, but the number of parts to be handled is materially reduced.

Wide spaced pillaring is, generally speaking, a modern development. Lloyd's first gave definite tables whereby the forest of small pillars could be replaced by more widely spaced and larger pillars, with girders under the decks to transmit the loads to these pillars. No weight saving is to be made, but greatly increased facilities for stowage results. Wide spaced pillars had been in vogue for some years before the classification printed rules gave tables for the same.

Topside tank ships have come to the front, and for vessels which have to make long oversea voyages in ballast, they, together with the usual double bottom, furnish a most excellent distribution of the ballest weight; particularly in bulk trade ships, where the space under the deck is apt to be left empty, the topside tank is well worth its cost. As a safety arrangement also they have points, the two sides, from the load waterline up, constituting a protection in the event of collision.

It is to be noted that the turret and trunk steamer have not lasted as general types; their construction takes place only very occasionally. The same may be said of whalebackers; though a Great Lake type, they are used on the ocean, but not to any great or growing extent.

There is one great advance to be noted in our period which is worthy of special mention, and that is the revival of the longitudinally framed ship, for which credit must be given to Mr. J. W. Isherwood. The adaptation of longitudinal construction to merchant steamers has been of singular advantage in several types, notably in oil

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† Naval Architect, New York Shipbuilding Company, Camden, N. J.

steamers. The system is ideal for oil steamers and all long and shallow types. For bulk and general freighters the advantage also is considerable, but is not so marked as for oil tankers. In all types there is an appreciable saving in weight. Costs usually compare favorably after the first ship at each yard has been built and experience gained. Torpedo-boat destroyers and light cruisers also can well be built on this system.

The advantages of the system are less structural weight, reduced vibration, greater longitudinal strength, and greater capacity in some instances; the disadvantages are transverses sticking out into holds, operative in some trades, and holding up coal or other bulk cargoes on the longitudinals. It is interesting to note that the total gross tonnage built and building to the system is nearly 1,500,000, which speaks for itself, as the period covered is under ten years.

The carriage of cooled and refrigerated cargoes has made considerable progress in the last ten years; fruit is carried by regular liners in vast quantities from the warmer to the colder climates, particularly bananas. The carrying of chilled and frozen meats has reached proportions undreamed of ten years ago, so much so that the carrying of live cattle has very largely ceased.

While it cannot be said that radio telegraphy has influenced cargo ship design, yet at the same time the installation of such apparatus is rapidly becoming universal, and indeed is now compulsory on all vessels carrying fifty or more persons; the greater ease of transmitting orders from agent or owner needs no comment.

The elimination of wood decks is noticeable; plain steel decks are the thing in freight spaces, and many substitutes for wood in living spaces are on the market.

Influence of the Panama Canal

The Panama Canal has already begun to influence ocean freighter design, and vessels for long voyages and of large dimensions are being constructed in more or less modest numbers. The American Hawaiian Steamship Company's vessels are probably the best type of large ocean carriers built for canal trade. The latest vessels of this fleet are worthy of a little study.

The ships are 430 feet by 53 feet 6 inches by 39 feet 6 inches to the shelter deck and carry 9,000 tons total deadweight on 28 feet draft. They have power for 12 knots at sea, and have limited passenger accommodations. They are fitted with all the decks their depth will allow, and are arranged for oil fuel, single screw drive.

Fast fruiters of large dimensions have also been the subject of numerous designs, their speed having been based on the average speed of freight across the continent. This will necessitate a sea speed in the neighborhood of 16 knots, which is quite practicable as far as the ship and machinery are concerned, and is, in fact, the general speed for a combined fruiter and passenger ship in the West Indian trade. It can be said that many designers are at work on ships for the canal trade, and that definite types will be evolved when conditions are more settled. Radical departures from standard types do not appear to be imminent; it is safe to say, however, that the ships will be both larger and faster than those in general use on either coast.

Large lumber steamers for canal trade are also under consideration. One design the writer has seen, prepared by Messrs. G. W. and J. S. Dickie, contemplates a vessel 440 feet long, 12 knots sea speed and 5,000,000 board feet of lumber; oil fuel and with ballasting arrangements such as will enable partial loads, including deck loads, to be safely carried, while collecting cargo from several points for the trip through the canal. A long trunk and elevated cargo handling gear are features of the design.

Terminal Facilities

The large amounts of money being spent on terminal facilities are bound to have an increasing effect on ship design. Take the Bush Terminal at New York as an instance. The writer calls several instances to mind where cargo ports had to be a fixed distance from the bows of a ship to suit openings in shed sides; it did not matter whether they came abreast the other breaks in the structure or not, a fine, new ship had to be butchered to suit some ramshackle old wharf that would not last five minutes in any fire that amounted to anything. These quaint old relics in the way of wharves are rapidly being replaced in all our big harbors. Wharves will, in future, be so arranged as to give reasonable latitude in ship arrangement. There mere fact that development is being allowed for will automatically take care of the ship's interest.

Rapidity of despatch becomes more important the larger the ship is; also, the larger the ship the more self-sustaining she becomes in the matter of minor repairs. It is a sign of the times to be noted that the ship's force are asked to do less and less while in port, at any rate among the large lines, so that they can have reasonable freedom in port and get home for just as long a time as under former conditions, with the longer wait in port. The gain due to a quick turn around each trip, might easily mean two or three voyages more per year.

The improvement in crew's quarters aboard ship has been noticeable of late years, and this is by no means confined to the ships of any one nation. This is one of the handicaps of American shipping that is being removed by the other fellow grading up, instead of ourselves grading down.

Lumber Steamers

Lumber steamers are in a class by themselves; they should be specially designed and proportioned for their trade, and when such is the case deck loads are by no means the menace they are in an ordinary steamer used to carry lumber cargo. Besides being of extra beam, the ship is built with a strengthened main deck and special bulwarks; these precautions, together with lashing chains, enable cargoes up to 14 feet high to be safely carried. Trouble is apt to arise when ordinary cargo steamers, designed for a hold cargo only, load lumber to their statutory (European) freeboard and carry a deck load to do it. The International Load Line Conference will have the question of the freeboard and deck loads of lumber steamers to consider. The technical press has lately contained considerable comment on this vexed subject. The fact that many lumber steamers are operated with oil fuel makes security of deck load doubly necessary. The solution is minute subdivision of oil tanks in both directions, so that it is not posssible to get large free surface losses in stability.

The deep centerline tank adopted by Mr. E. S. Hough meets this point admirably, though open to the defect of large calking surfaces exposed to damage, as compared with ordinary deep tanks. As compared with ordinary double bottom tanks, the deep centerline tank is considerably less liable to damage and possesses other advantages to compensate for the large riveted areas.

It would appear to be altogether just to allow properly designed lumber steamers to load deeper than ordinary cargo steamers, on account of the buoyancy of the cargo. The beam of the vessel is a fundamental consideration in this, and in the present freeboard regulations beam is only casually mentioned. It is safe to say that the problem is by no means unsolvable, and that with the vast amount of data recently prepared a way will be found that will be just to all concerned, owners, underwriters and crew.

An interesting solution of the lumber steamer problem is that afforded by the *William O'Brien,* a vessel designed by Mr. E. S. Hough, and built at the New York Shipbuilding Company's yards in Camden, N. J. The deck load is carried in a light superstructure over the three forward holds, the fourth being open, as usual. The superstructure protects the dry and finished products from the sea, and in addition the high sides extend the range of stability. The lumber is lifted aboard in heavy iron straps, making packages four feet square, which are used again to unload at the other end of the trip. This vessel is served by special overhead loading and unloading plants, and consequently does not carry her own gear. The high sides would necessitate an elevated control platform for operating the winches in an ordinary, self-discharging lumber steamer.

This superstructure, if fitted all the way between poop and forecastle, would have marked advantages to compensate for its extra first cost, namely:

1. Protects cargo from loss by wave action.
2. Lower insurance rates for under deck cargo.
3. Stronger ship due to great depth of girder.
4. Enables large hatches to be more easily obtained, due to height above sea.
5. Enables other cargoes to be carried to full capacity of the ship, protected from the weather.

These advantages apply to a vessel carrying wet, unfinished lumber, as well as one carrying dry, finished cargoes.

Motive Power

Turning now to motive power, the last ten years have witnessed greater changes in this field than can readily be grasped. Ten years ago it is safe to say that the well-nigh universal method of cargo ship propulsion was by means of compound or triple expansion engines, with an occasional quadruple expansion engine here and there. Scotch boilers were in undisputed possession of the field, and were coal fired; this can be said because paddle wheels were not applied to ocean cargo steamers during our period. What do we find to-day? The whole marine engineering world is considering several alternatives. Steam turbines have made wonderful strides, motor ships are quite common, and cargo steamers are being driven by high speed turbines, mechanically geared down to normal propeller speeds. Electric reduction gear is being seriously proposed, likewise hydraulic gearing, with a view to using turbines for prime movers. Scotch boilers still hold the field for ocean cargo ships, except in isolated cases, but oil fuel is being used in many routes where the supply is assured, coal no longer being, to all intents and purposes, universal.

Reciprocating engines are still the principal type of motive power, but geared turbines are making a splendid start, being capable of, roughly, a knot greater speed on the same fuel consumption in an average ship.

Motor ships, particularly when twin screws are adopted, are making progress for low powers only. Electric drive has been tried in a few cases, but has hardly emerged from the purely experimental stage for cargo ships.

Of the several alternatives the geared turbine looks the most promising for vessels of this type, particularly since improved methods of gear cutting have been adopted. The number of cargo vessels now at sea and under construction fitted with mechanical gearing and steam turbines is in excess of thirty. Reports from the vessels in service state that there is no appreciable wear on the pinion teeth after being in constant operation upwards of two years.

The saving in economy of fuel consumption for a single screw installation averages about 15 percent, and in case of a twin screw installation a saving in fuel consumption will be at least 20 percent over reciprocating machinery.

Another point to be considered in applications of this type is the question of saving in weight of machinery and engine room space. A geared turbine installation effects a saving in the machinery weights averaging 10 percent, and in many cases one or two frame spaces can be saved in the length of the engine room.

To keep up with the adoption of internal combustion propelling engines, attention is being given to reducing the number of steam auxiliaries, though the exhaust gases from the main engines can be used for keeping steam on a donkey boiler. Particular attention is directed to the hydro-electric steering gear now being fitted on quite a number of ships. An oil-fired donkey boiler and steam winches for port use offer a good method for cargo and anchor handling purposes. Motor-driven pumps are common, and so on, down the list.

Present Status of Ocean Cargo Ships

As regards the present status of ocean cargo ships, it is evident that we are at the beginning of a period of increased activity; large ships are the rule, notably so in oil tankers, in which longitudinal framing is firmly established. All eyes are turned towards new types of propelling machinery and considerable economies of propulsion are confidently looked forward to, and have already been realized in some instances, notably in the case of geared turbines and of motor ships of low powers.

The increased attention given to safety of life at sea will probably result in cargo vessels being required to carry boats enough for all hands on each side of the ship, this being law in Great Britain already. Subdivision as effective as in passenger ships is not practicable, except in a few cases, such as oil tankers and bulk carriers that are unloaded by ample overhead gear.

Tug Boat S. M. Otis Equipped With Oil Engines

The 45-foot tug boat *S. M. Otis,* illustrated, which is owned by the Otis Manufacturing Company, New Orleans, La., has been in service for over four years in British

Motor Tugboat *S. M. Otis*

Honduras, towing rafts of mahogany logs from the northern boundary down to Belize. This boat draws about 3 feet of water and makes about 9½ or 10 miles an hour in light condition. She is equipped with a 45-horsepower, three-cylinder Mietz & Weiss marine oil engine manufactured by the August Mietz Foundry and Machine Works, New York. In addition to towing mahogany logs in rafts of about 300 logs, the boat transports laborers and provisions from place to place as required.

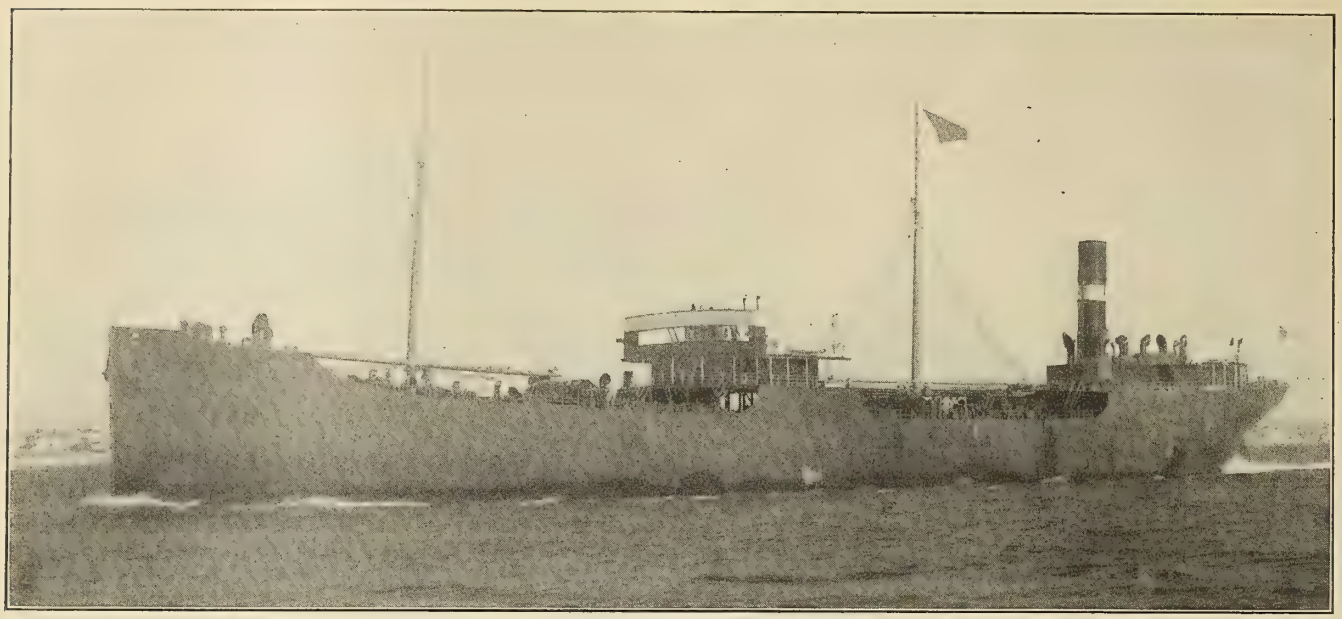


Fig. 1.—S. S. *Texas* on Her Maiden Voyage

Oil Tank Steamship Texas

Eleven-Knot Vessel of 9,100 Tons Deadweight Capacity Built at the Fore River Shipyard

The first of the Texas Company's new fleet of oil tank steamers to be completed is the *Texas,* built by the Fore River Shipbuilding Company, Quincy, Mass. The vessel has two continuous steel decks, a raised forecastle, bridge and poop decks and a lower deck in the package freight hold. The hold is divided by oiltight bulkheads into compartments for sixteen main oil cargo tanks, sixteen summer tanks, fuel oil tanks, two pump rooms, a cargo hold forward, machinery space aft, deep trimming tanks both forward and aft and a double bottom under the engine and boiler space. The ship is schooner rigged, with two steel masts. The principal dimensions are as follows:

Length over all.....430 feet
Beam ..... 56 feet
Depth .....32 feet 9 inches
Load draft .....25 feet 6 inches
Deadweight carrying capacity at above draft, 9,100 gross tons
Capacity of cargo tanks.....73,000 barrels
Capacity of cargo tanks.....3,066,000 gallons
Speed .....11 knots

Propulsion is by a single screw driven by a three-cylinder, triple-expansion engine, with cylinders 26½ inches, 44 inches and 74 inches diameter by 51 inches stroke, designed to run at a maximum speed of 75 revolutions per minute. Steam is supplied by three single-ended Scotch boilers, 15 feet 3 inches diameter by 11 feet long, working at a pressure of 190 pounds per square inch. The boilers are oil-fired, being fitted with a mechanical atomizing system. The vessel is also equipped with a donkey boiler.

The vessel has been designed to carry various grades of refined oil without danger of mixture. The cargo pumping system has been carefully worked to the highest point of efficiency. All living quarters, which are carefully planned, are provided with a steam heating system and

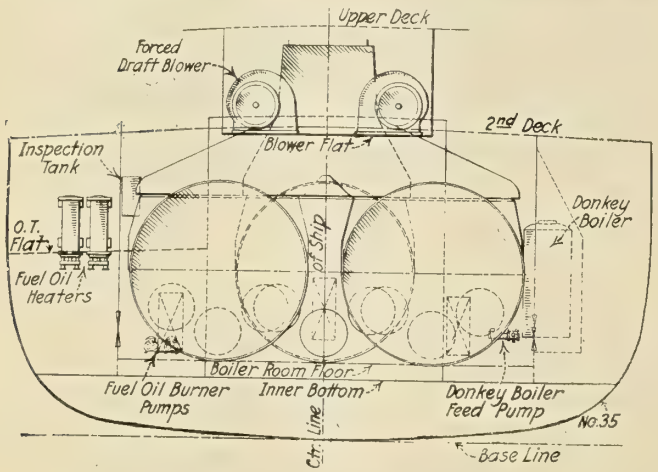


Fig. 2.—Section Through the Boiler Room

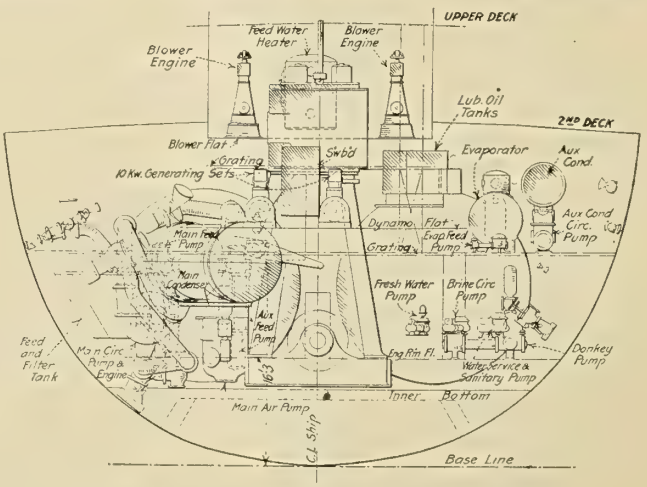


Fig. 3.—Section Through the Engine Room

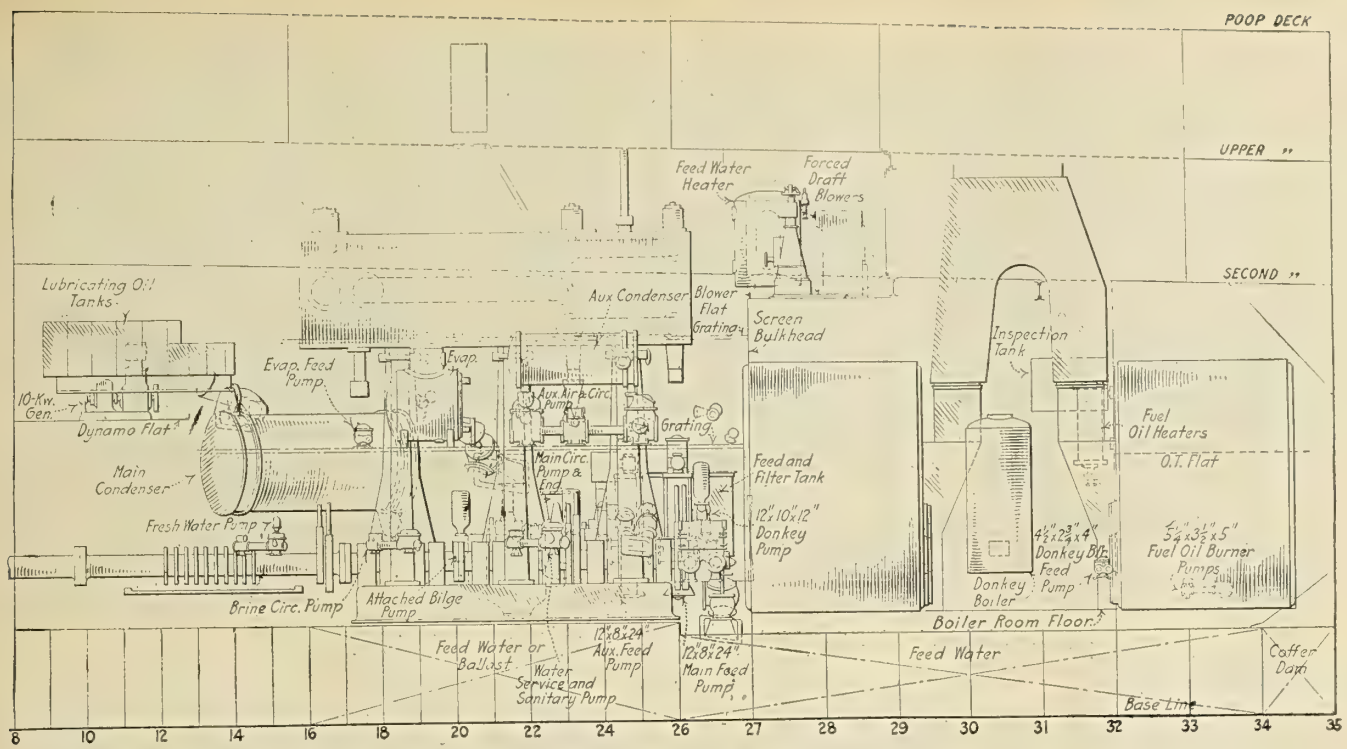


Fig. 4.—Longitudinal Section Through the Machinery Space

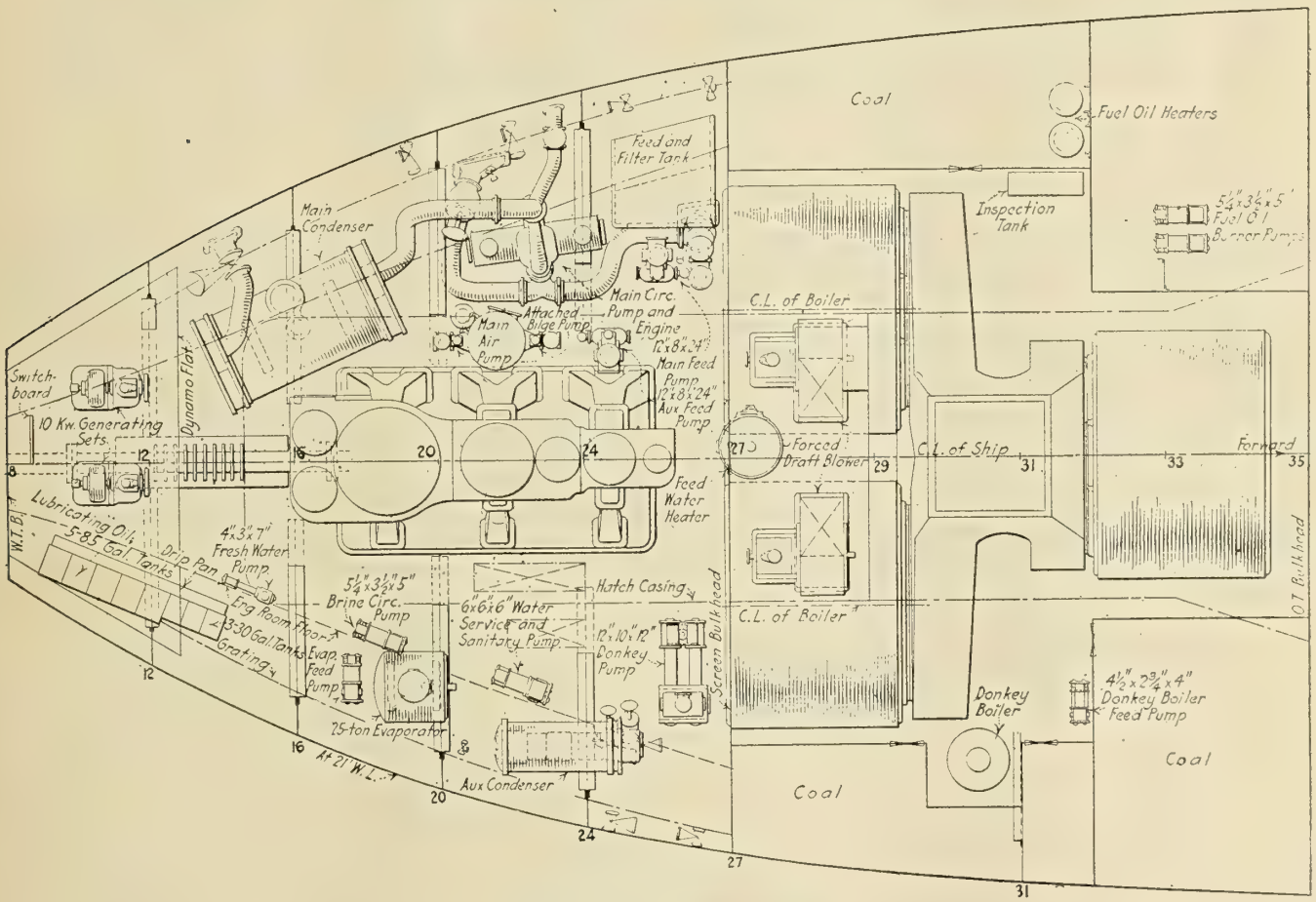


Fig. 5.—Plan of Machinery Space

steam heating coils are provided for the fuel tanks and such other tanks as may be used for heavy oil. Steam fire-extinguishing pipes are also run through all tanks. The equipment of the ship also includes a refrigerating plant and a complete electric lighting outfit. The vessel was designed by Mr. George B. Drake, assistant manager of the marine department of the Texas Company, New York.

Fig. 1.—Model of Submarine Mother Ship Built by the Fiat-San Giorgio, Spezia, Italy

Need of an Efficient Mother Ship for the Submarines of the United States Navy

Description of New Type of Submarine Mother Ship Designed by Major Laurenti for the Fiat-San Giorgio, Spezia, Italy

BY R. G. SKERRETT

A good deal of misguided energy is being spent in this country in urging very extensive additions to our submarine flotilla. The term "misguided" is used because the campaign for increase totally ignores our deplorable deficiency, due to shortsightedness, in other branches of this underwater service. The story of the loss of the *F*-4 should bring this lack to public attention, and there should be no lagging on the part of our citizenry in demanding that our shortage be corrected with the least possible delay.

The United States submarine *F*-4 sank outside of Honolulu harbor on March 25 while maneuvering submerged, and her shattered hull was not brought again to the surface until August 29, when it was towed into port and made ready for dry-docking. The official inspection of the stricken craft disclosed that the immediate cause of her destruction was due to an explosion of battery gas, but unquestionably the primary or promoting cause was some structural weakness through which sea water found its way into the cell compartment.

We must remember that such a weakness might be occasioned in a variety of ways. Barnacles or some other tropical marine growth might have clogged an outboard connection leading to a ballast tank or the seating of an

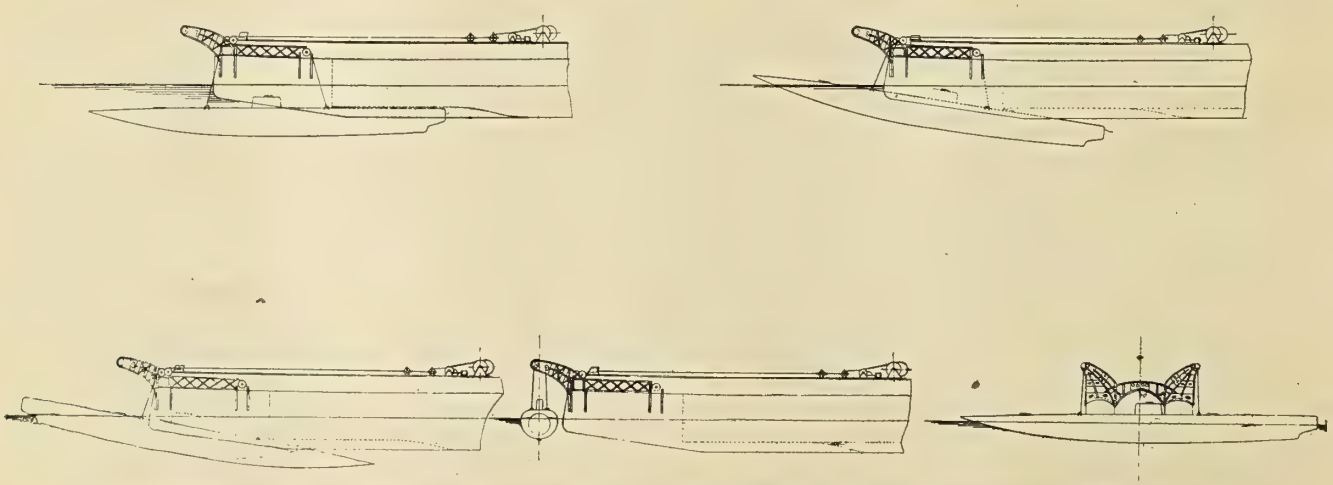


Fig. 2.—Diagram, Showing Method of Raising a Foundered Submarine with Gear at the Stern of the Mother Ship

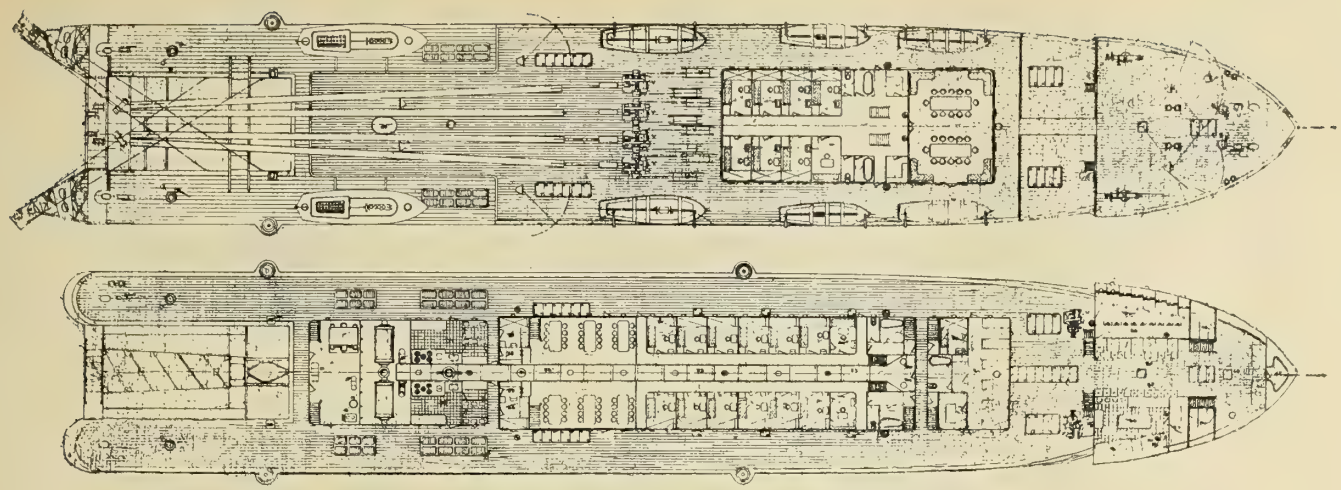


Fig. 3.—Deck Plans of Mother Ship

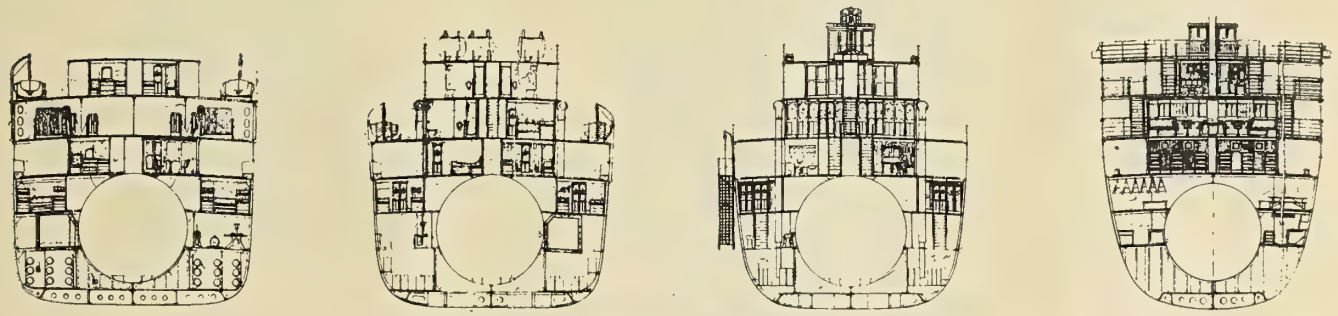


Fig. 4.—Sections Through Mother Ship Forward of Amidships

exhaust or intake valve. Again, acid from the cells, spilled by the motion of the boat, might have reached the hull plating and damaged it, and, possibly, vital steel work might have corroded from other causes and escaped detection. Anyway, the weakness yielded under the pressure of a normally deep submergence. There was sudden gassing, there was a spark, either from a short circuit or the working of a switch, and a fatal explosion followed. Control of the boat was lost, and down she quickly sank to nearly 300 feet, and in through the breach, no matter how moderate, the sea rushed under that great head. The men inside, if not killed by the explosion, had no chance, and were probably drowned before they had time to recover from the initial shock.

The catastrophe might, in all likelihood, have been avoided had we the proper auxiliary equipment for our submarine divisions in the shape of thoroughly up-to-date depot or mother ships. By mother ships we do not mean makeshift mobile supply bases, but vessels of a composite nature capable of ministering to the peculiar needs of underwater craft. To-day we are woefully lacking in this very important particular, and any further increase of our submarines without additions of this sort, too, amounts to little short of a bid to disaster and more numerous unnecessary losses.

The hulls of all of our submarines are of steel, and steel will rust and pit deeply unless it be watched continually where exposed to water or to moisture. The least evidence of corrosion must be dealt with promptly and the scraped surface repainted. In no order of vessels is this vigilance more necessary than in underwater craft. Unfortunately this is not quite practicable to the desired degree in certain of the water-ballast tanks, and even if possible it is seriously debatable if the work of scraping and painting is done as thoroughly as the nature of the risk of submarine service exacts. Therefore, some check should be available for the speedy and safe detection of structural failures due to insidious corrosion in out-of-the-way parts of such complex boats.

An ordinary surface craft is docked for examination at regular intervals in order to see that she is fit for sea service and capable of floating. A submarine, on the other hand, when similarly dry-docked, is inspected, scraped and painted for the purpose of making her equal to a twofold service: on the surface and below the waves. Not only that, but she must be strong enough to withstand a compressive force due to a sudden and deep submergence if she be carried down by accident or intentionally submerged to that depth for maneuvering or military purposes. It must be clear that merely dry-docking and visual examining will not suffice. The only satisfactory inspection would be one that physically simulated or duplicated the stresses due to actual submergence, and this under circumstances that would permit men to be retained safely inside of her the while.

Of course, this procedure is now pursued by us when testing new submarines at the time of their acceptance trials. Then they are purposely drawn down to a depth of 200 feet, and the inspectors can see or readily trace the source of all leaks. But, alas! this sort of testing is expensive; *it is done only once during the lifetime of a boat,* and it requires a favorable spot where water of that actual depth can be found. Even so, the state of the weather may occasion costly delay. The older a submarine grows the greater is the danger incident to structural deterioration, and, therefore, the more need of sub-

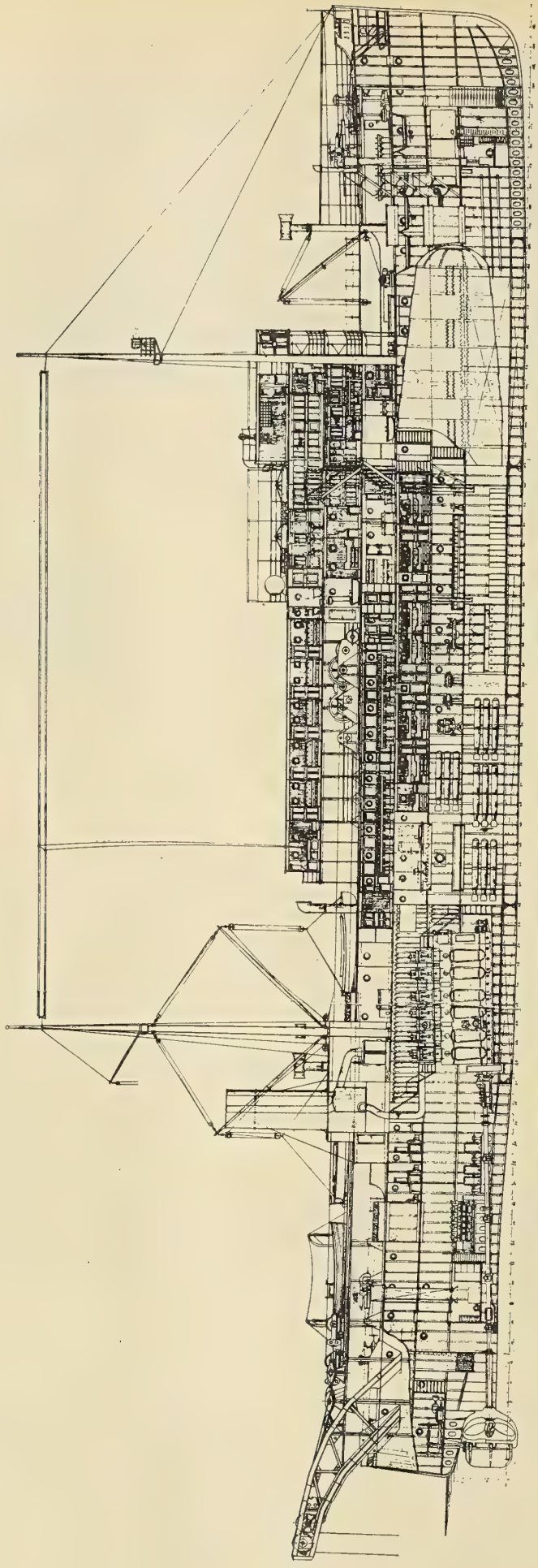


Fig. 5.—Inboard Profile of Submarine Mother Ship Built by the Fiat-San Giorgio, Spezia, Italy, from Designs by Major Laurenti

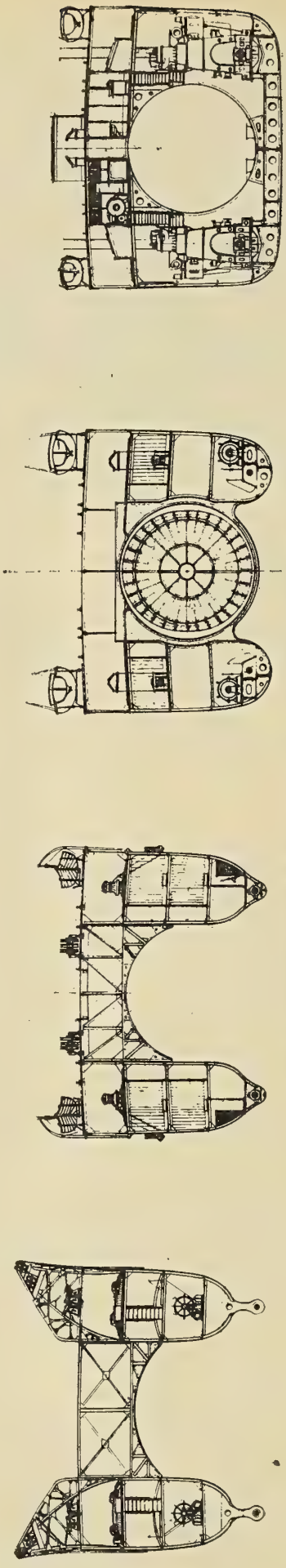


Fig. 6.—Sections Through Machinery Space and at Stern of Mother Ship

mergence tests of this sort. It is not right to expose the crews of these vessels to sudden peril in ordinary peace-time practice when there are facilities available to-day not only for guarding against this menace, but for greatly increasing the military effectiveness of these boats in time of war.

The well-known Italian firm, the Fiat-San Giorgio, of Spezia, has built a special submarine mother and depot ship both for the home Government and for the Brazilian navy, and what we need are three or four of the same kind here. There should be two available for each coast, and more should be built as our flotilla of subaqueous craft grows. The vessels turned out by the Italian yard are designed to discharge manifold duties. They are mobile supply and repair bases containing tubular testing docks and capable of promptly salving a sunken submarine if within the reach of divers. This, as will be readily recognized, is a very notable advance over the simple testing dock evolved by the same enterprising company a few years ago, for the present ships are self-contained and capable of making extended cruises. In turn, they add very materially to the strategic value of a flotilla of submersibles so convoyed.

Submarine Mother Ship Built by the Fiat-San Giorgio

In order that we may get a fair idea of the design of these novel vessels the following general particulars and principal dimensions are given:

Length between perpendiculars	328 feet 00.0 inches
Beam, maximum	51 feet 6.0 inches
Draft when ready for sea and all stores aboard	13 feet 11.25 inches
Total length of cylindrical testing dock	209 feet 11.66 inches
Maximum useful length of dock (internal)	180 feet 2.25 inches
Diameter of entrance (rear end) of cylinder	24 feet 9.66 inches
Internal diameter of cylindrical testing dock	23 feet 4.00 inches
Motive power, two heavy-oil engines driving twin screws.	
Maximum speed	14 knots
Radius of action, at 10 knots speed	4,000 knots

As the present war has amply demonstrated, service aboard submarines is exceedingly exhausting, and in the case of the German U- boats they have suffered from the added handicap of operating from fairly distant stationary bases. It has been with these latter craft largely a matter of physical endurance on the part of the personnel. It was in anticipation of these demands that Major Cesare Laurenti, of the Fiat-San Giorgio, planned this particular order of mother ship. His aim was to provide a place of refuge for tired submarine crews, as well as a source of operative supplies; in fact, a mobile base for a tactical unit of six submersibles—the flotilla to consist of three boats of 400 tons submerged and three of 650 tons submerged.

When mothering a flotilla of this make-up, this depot ship is able to fill four times the fuel tanks of the smaller submersibles and to do a like service three times for the big boats as well. Thus, while tripling or quadrupling, as the case might be, the radius of action of these submarines, this unique craft can cover on her own account a matter of 4,000 nautical miles. The operative crew of the ship is 140 men, and there are spare accommodations for 150 of the personnel of the flotilla. In this way the men of the submarines can be given a chance to rest from time to time, especially when their boats are alongside for repairs, refueling, revictualing, or for the recharging of the batteries of the submersibles. There is also a commodious sick bay.

The mother ship has a reserve of cells suitable for both of the foregoing types of Laurenti submersibles, and, if need be, can supply at once fresh accumulators for each of the six boats to the number of half the total required. This makes speedy substitution possible and amply takes care of the probable maximum demands of the heaviest service stresses. Besides providing new cells, the dynamos of the depot ship are available for recharging the accumulators in the submarines, thus obviating the use then of the engines of the submersibles and, for the time being, allowing the crews of the underwater craft to rest or to attend to other matters.

Propelling Machinery

The ship is driven by two heavy-oil Fiat-Diesel two-cycle reversible engines, each of six cylinders and capable of developing at full speed 3,200 brake horsepower, and when making 130 revolutions a minute, able to develop 2,200 brake horsepower. The air compressors are of the three-stage type and are designed to serve the double purpose of starting the engines and pulverizing the fuel. They are directly driven, but are so arranged that they can be easily disconnected from the motors in order to facilitate their repair when the engines are working. Each motor is fitted with a spare compressor driven by an auxiliary engine. These compressors are designed to work to 50 atmospheres, and will be able to actuate the engines at one-third of their normal charge. Besides, there are two other compressors, electrically driven, for service in charging up to 175 atmospheres, when this is required for recharging the air flasks.

With the latter compressors it will be possible to refill the flasks of the submersibles with compresed air at 175 atmospheres. For this purpose there is a distributing system extending the length of the depot ship with connections at many points by which piping can be led conveniently to the submarines alongside. Assuming the flasks of the boats to be exhausted, the capacity to recharge and the time required by this plant would be as follows:

To recharge three of the 650-ton boats	6.5 hours
To recharge two 650-ton and one 400-ton boats.	5.45 hours
To recharge one 650-ton and two 400-ton boats.	5.0 hours
To recharge three 400-ton boats	4.15 hours

Interchange of Crews

In this way any drain on the motive power of the submarines would be avoided, and, while undergoing recharging, the personnel of the submersibles could be otherwise employed or permitted to rest, if that be desirable. It must be understood, of course, that the bigger part of the crew of the depot ship is composed of trained submarine men, and this allows of an exchange of duties and regular rotation in underwater work. The advantage of this must be obvious.

There are two electrically driven auxiliary pumps serving the forced lubrication system of the engines. These pumps have a capacity of 30 tons per hour. In addition, there are two bigger electrically driven pumps with an hourly capacity of 100 tons, designed for auxiliary circulating duty with the main propelling engines. With these precautions the continual working of the engines is amply assured.

There are to be two electro-generating sets of 150 kilowatts placed in the engine rooms. These generators

are driven by internal-combustion engines and will furnish all the power needed to operate the various electrical apparatus and motors aboard the depot ship.

In order to make even more certain of the uninterrupted working of the main and auxiliary engines, another spare compressor is provided, steam driven, having a capacity of 20 liters per minute at a pressure of 175 atmospheres. The principal purpose of this compressor is to supply air for starting the electro-generating set in case the air flasks on board the ship should be exhausted. It will help also to refill the ship's flasks, and, in time of urgency, to recharge the flasks of the submarines, thus supplementing then the other compressors. There is another steam-driven compressor of the plunger type capable of delivering 1,200 liters per minute at 6 atmospheres. This is connected with the cylindrical dock and provided for the purpose of testing submarines when inside that structure.

Operation of Testing Dock

We have already described the Laurenti submarine-testing dock in its simple form. Essentially there is no difference in the present apparatus save that the cylinder is inside of the mother ship. The cylindrical testing dock is formed of high tensile steel, the forward end being permanently sealed and the stern end closed by a removable steel caisson of globular form. This caisson has inherent stability enough to maintain it upright when floated free of the entrance to the testing dock. The draft of the caisson is controlled by water ballast. When in the sealing position the caisson is seated upon a heavy annular india rubber gasket, and is locked so as to insure water tightness whether the maximum pressure be exerted from within or outside of the dock. To release this gate, just enough water ballast is blown to lift the caisson a few inches. Then it can be swung around upon its vertical axis until in line with the longitudinal centerline of the cylinder. In this position it can be drawn out and aft so as to give a clear passage either for the entrance or the exit of a submarine.

It is hardly necessary to go into details regarding the modus operandi of testing an underwater boat; but for the sake of those unfamiliar with the earlier form of the Laurenti dock it will probably suffice to be told that a submarine, after entering the dock and settling upon the blocks arranged for her and being centered vertically by means of other blocks so she can not rise, is surrounded by water which fills the cylinder. Then pressure is applied to this water by means of the plunger pump, and gradually this is raised to represent the hydrostatic stress of any equivalent submergence. All the while there are people inside of the submarine for the purpose of inspection, and the officer in charge is in telephonic communication with the engineer directing the working of the pressure pump. Instantly the pressure upon the submarine can be reduced by the stopping of the pump and the opening of suitable exhaust valves.

The whole operation of testing is exceedingly simple and can be carried out in harbor or at any convenient point where the mothership and the submarine rendezvous. These tests can be made at frequent intervals and unsuspected weaknesses can thus be promptly detected and needless risk of life and property avoided. For salvage work in connection with a sunken submarine, the special windlass and the derrick placed at the stern of the ship would suffice. Some of our illustrations show just how this apparatus would work when raising a foundered underwater boat to the surface.

Both the Italian and Brazilian motherships are armed with rapid-fire guns for the purpose of dealing with either destroyers or enemy submarines. Each of these vessels carries four quick firers of 100-mm caliber and four of 57-mm caliber, together with an ample supply of ammunition.

Motor Ship's Five-and-a-Half Years' Service

In the early part of 1912 the Diesel-engined motor cargo ship *Sembilan* left Europe for the Dutch East Indies, where she has remained in steady service ever since, giving to her owners the same consistent work that could be expected of a high-class steam vessel. The performance of this ship is all the more creditable when it is considered that her engine was built before the advent of the much-discussed motor ship *Selandia*. In fact, the *Sembilan* was the second seagoing vessel to be installed with direct-reversible Diesel engines, the first being the *Vulcanus*.

Placed in service in November, 1911, the *Sembilan* plied between Holland and England for several months before her departure to the other side of the world, in order that her working could be closely supervised. Everything being considered satisfactory by her owners and builders, she soon left for Weltevreden, Batavia, Java. According to reports from Mr. J. Jameson, chief engineer of the Koninklijke Paketvaart Maatschappij (Royal Packet Line), during her first three years' service in the Dutch East Indies the vessel completed ninety voyages, and the total amount spent in repairs was $2,400 (£490); also very little time was lost due to being laid up for this purpose. It should be noted that the *Sembilan* is engaged in a service where there are practically no facilities for proper repairs, and to maintain a regular schedule a ship must have reliable machinery. Four other ships with the same type of propelling machinery are engaged in the same service, and none has returned to the builders' yard for repairs.

The *Sembilan* was built by the Netherlands Shipbuilding Company, of Amsterdam, and her machinery was designed and constructed at the Werkspoor Works of the Netherlands Engineering Company, also of Amsterdam.

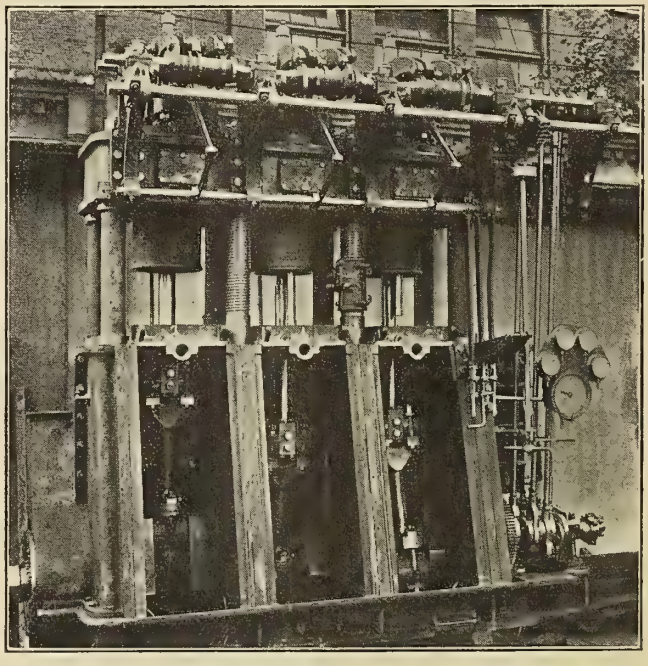


Fig. 1.—Reversible 250 Horsepower Diesel Oil Engine, Showing Crank Chamber Doors Removed

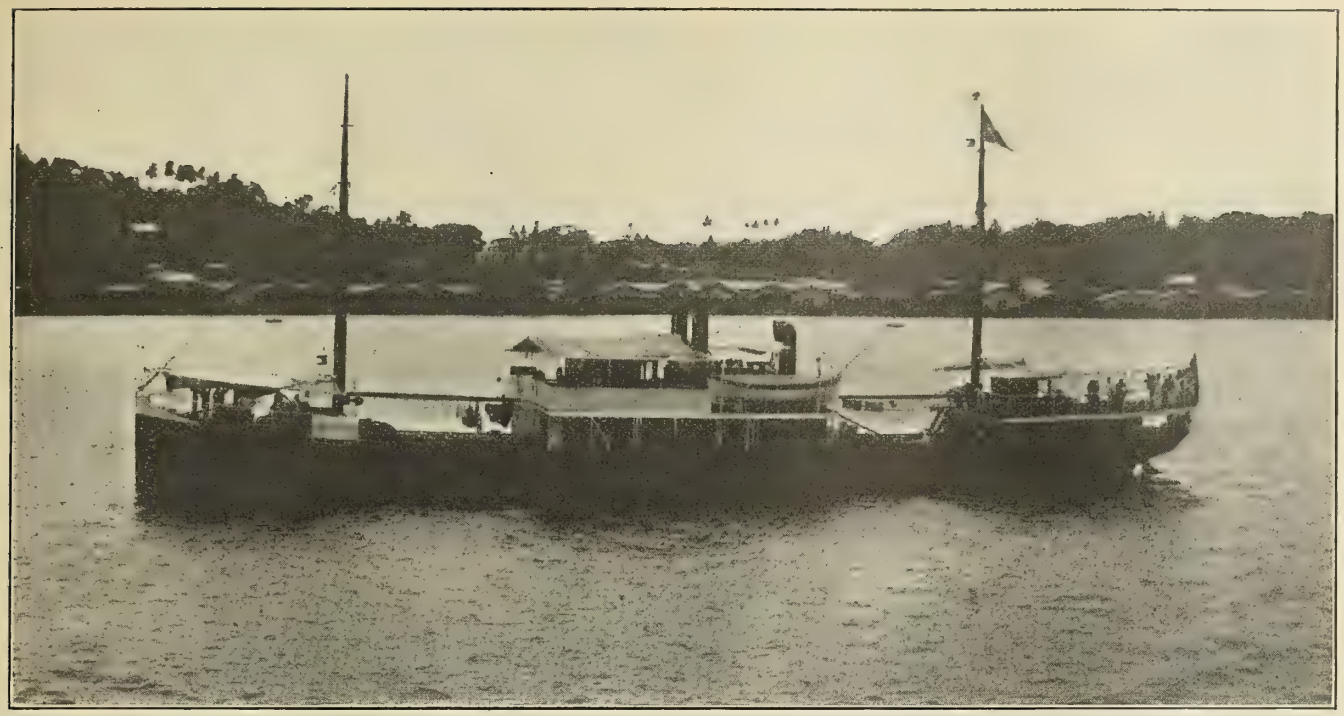


Fig. 2.—Werkspoor Diesel-Engined Motor Ship *Sembilan*

The vessel is 152 feet long by 26 feet beam and has a carrying capacity of 300 tons, on a maximum draft of 9 feet. Her gross tonnage is 372, and her net tonnage 132 tons. In appearance there is little to distinguish her from an ordinary steam cargo vessel, except that her twin funnels are arranged thwartships, one being used for ventilation and the other for the exhaust gases. Her average loaded speed is 8 knots, or 9 knots light, yet her service fuel consumption of residual oil, including auxiliaries, is not over 180 gallons per 24-hour day.

Her main engine consists of a four-cycle type, directly reversible, Werkspoor crosshead Diesel-type motor with three cylinders, 16-inch bore by 20-inch stroke, delivering in aggregate 250 brake horsepower at 200 revolutions per minute. At the forward end of the engine is coupled a three-stage air compressor, which supplies air to storage bottles for starting, reversing and fuel injection. Fuel is injected at 900 pounds per square inch, but for starting, air is admitted to the cylinder at 225 pounds per square inch. At the forward end of the engine room there is a Werkspoor-Diesel engine of 25 brake horsepower, which drives a three-stage air compressor for operating the deck winches. This compressor can be used for charging the storage tanks in case of breakdown of the main compressor.

In the engine room there are two engineers and two greasers, or a saving of three hands, compared with steamers of similar capacity on the same service. The remainder of her crew consists of the captain, two mates, bo'sun, carpenter, steward, cook, four deck hands and two boys, her particular service calling for this large crew.

Lloyd's Quarterly Shipbuilding Returns.—According to Lloyd's returns, which only take into account vessels of 100 tons and upwards, the construction of which is actually begun, there were 424 merchant vessels of 1,423,435 gross tons under construction in the United Kingdom at the close of the quarter ended March 31. The tonnage now under construction in the United Kingdom is about 60,000 tons more than that which was in hand at the end of the last quarter, but about 164,000 tons less than the tonnage building twelve months ago.

Annual Meeting of the Institution of Naval Architects

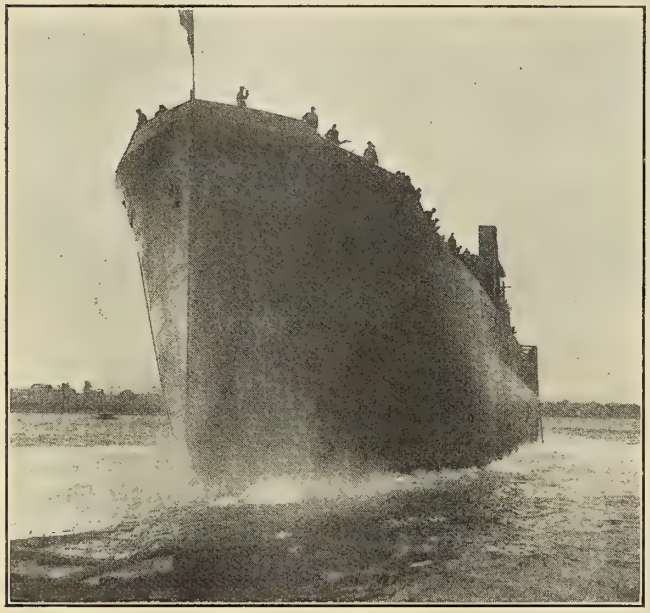
At the annual meetings of the Institution of Naval Architects, held in the Hall of the Royal Society of Arts, John street, Adelphi, London, W. C., on Wednesday, April 12, and Thursday, April 13, the following papers were read and discussed:

1. "On the Work of the Load Line Committee." By Sir Philip Watts, K.C.B., F.R.S., LL.D., D.Sc.
2. "Some Questions in Connection with the Work of the Load Line Committee." By W. S. Abell.
3. "The Laws of Skin Friction of a Fluid in Stream Line and in Turbulent Motion Along a Solid of Great Length." By Charles H. Lees, D.Sc., F.R.S.
4. "Skin Friction Resistance of Ships and Our Useful Knowledge of the Subject." By G. S. Baker, R.C.N.C. (ret.).
5. "Experiments to Determine the Resistance of Bilge Keels to Rolling." By Professor T. B. Abell.
6. "An Experimental Tank Reproducing Wave Motion." By Colonel G. Russo, R.I.N.
7. "A Brief Summary of the Present Position of the Marine Diesel Engine and Its Possibilities." By Engineer-Lieutenant W. P. Sillince, R.N. (ret.).
8. "On the Co-ordination of Propeller Results." By J. Denholm Young.
9. "Note on Maximum Propulsive Efficiency of Screw Propellers." By T. C. Tobin.
10. "Subdivision of Merchant Vessels: Reports of the Bulkhead Committee, 1912-1915." By Sir Archibald Denny, Bart., LL.D.
11. "Strength of Watertight Bulkheads." By J. Foster King.
12. "Some Effects of the Bulkhead Committee's Reports in Practice." By A. T. Wall.
13. "Notes from a Collision Case." By John Reid.
14. "Shipyard Cranes of the Rotterdam Dockyard Company." By M. G. de Gelder.

Launching of the Tank Steamer Cubadist

The steamship *Cubadist,* launched on April 8 from the yards of the Fore River Shipbuilding Corporation, Quincy, Mass., and christened by Miss Lucy Pettengill Currier, daughter of Hon. Guy W. Currier, of Boston, Mass., is a steel tank steamer for the Cuba Distilling Company, New York, designed primarily for the carriage of molasses in bulk, but so arranged that she may be employed in the carriage of bulk petroleum.

The *Cubadist* is a two-deck vessel with poop, bridge and forecastle, and is of the following dimensions: Length



S. S. *Cubadist*

between perpendiculars, 389 feet; breadth, 54 feet 6 inches; depth to upper deck, 32 feet 6 inches.

She will carry about 1,500,000 gallons of molasses on a mean draft of 25 feet.

As this vessel collects her cargo from Cuba and the neighboring islands, special attention has been given by the builders to the question of accommodations for the officers and crew. The quarters for the navigating officers, together with those for the wireless man and chief steward, are located under the bridge deck, so that easy and rapid access can be had to the bridge at all times; the quarters for the engineer officers are located in a Liverpool house around the engine casing on the poop deck, while those for the oilers and firemen are located below the poop deck.

Unlike the usual design of tank vessels, the *Cubadist* has a deep double bottom all fore and aft, and the inner bottom is recessed at the after end in each of the eighteen cargo holds to form suction pockets for the efficient discharging by the pipe line. When carrying molasses the deep tanks above the inner bottom only will be employed, but oil will be carried both in the main cargo tanks and in the double bottom tanks, thus permitting the carriage of 2,250,000 gallons of oil on the same draft as that given above for the molasses.

For the discharging of the cargo there is a pump room amidships in which are located an 18-inch by 12-inch by 18-inch horizontal duplex cargo pump and a 16-inch by 10-inch by 18-inch duplex ballast pump, so interconnected that both pumps may be employed in clearing the main tanks, for one pump may be employed on the main tanks and the other on double bottom tanks simultaneously. These pumps are connected to a 14-inch main line all fore and aft, from which are led 12-inch branches to each tank and so arranged that the liquid cargo may at any time be transferred from one tank to the other through the pumping system.

The propelling machinery consists of one vertical triple expansion engine driving a right-hand propeller. The cylinders are 25 inches by 41 inches by 68 inches diameter, having a common stroke of 48 inches.

Steam will be supplied at a pressure of 190 pounds from three single-ended boilers, 14 feet 2 inches mean diameter by about 11 feet 10 inches long, having a total heating surface of 7,407 square feet.

The *Cubadist* is the first of three vessels now under construction at the Fore River Shipbuilding Corporation for the Cuba Distilling Company, and will be ready for service early this month.

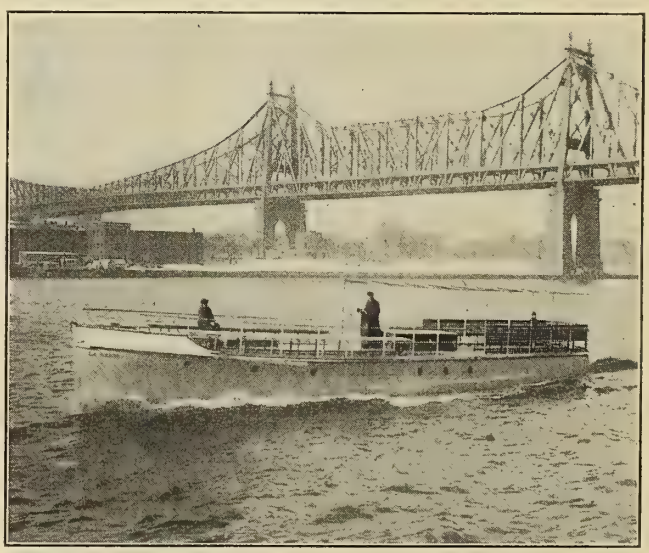
Sixty-Four-Foot Steel Passenger and Cargo Boat for the West Indies

The Welin Marine Equipment Company, Long Island City, N. Y., has recently completed for service in the West Indies the 64-foot steel passenger and cargo boat illustrated. This boat is designed to meet the requirements for carrying passengers, mail and freight, and is fitted for use in the open sea.

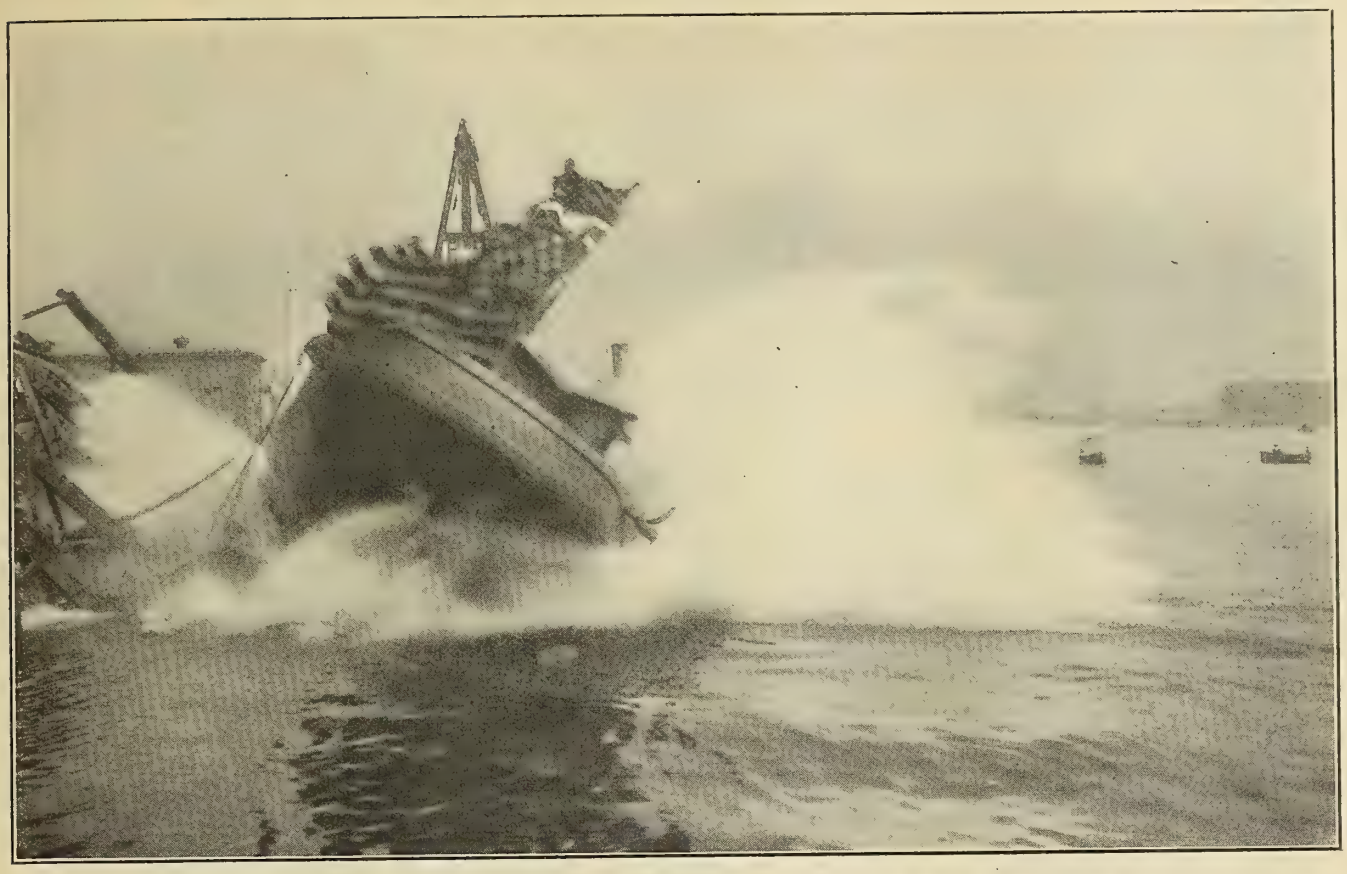
The hull is 64 feet long, 12 feet beam, 5 feet 6 inches depth amidships, and in normal load condition, that is, with a load of from 7 to 8 tons, will have an extreme draft of about 3 feet 6 inches. Propulsion is by a 65- to 75-horsepower Standard motor supplied by the Standard Motor Construction Company, Jersey City, N. J. On trial a speed of 12 1/3 miles per hour was attained.

Seats are provided for 40 second-class passengers forward, and for 25 passengers aft, while standing room is provided for 20 additional second-class passengers.

The boat is framed with 1½-inch by 1½-inch by ⅛-inch galvanized steel angles spaced about 15 inches. No. 12 B. W. G. galvanized sheet steel floors are flanged and riveted to the bottom and flanged straight on top to take cross bars for the flooring. There are three watertight



Steel Passenger and Cargo Motorboat Built by the Welin Marine Equipment Company, Long Island City, N. Y.



Naval Tug *Pocahontas*, Launched Sidewise on Temporary Ways from Sea Wall at the Norfolk Navy Yard

bulkheads, one forward and one just forward and one just aft of the engine room space. The shell plating is of No. 12 B. W. G. galvanized sheet steel.

The engine is located somewhat aft of amidships. Over the engine room is fitted a wooden trunk with a sliding hatch and hinged windows. A built-in berth is fitted on each side of the engine in the engine room. The crew's quarters are forward of the engine room, and access is furnished by means of a large raised hatch. Aft of the engine room there is a flush hatch in the deck, giving access to the cargo space. A gypsy windlass is installed on two nigger heads forward, and a single bitt is fitted aft.

Tug Pocahontas Launched at the Norfolk Navy Yard

The *Pocahontas,* a modern seagoing tug built at the navy yard, Norfolk, Va., was successfully launched on April 1 in the presence of the commandant, industrial manager and officers attached to the yard, the mayors of Norfolk and Portsmouth, Va., and other invited guests. Miss Eleanor Graham Briggs, the daughter of Lieutenant-Commander Wm. G. Briggs, U. S. N., christened the vessel.

The launch was unusual for the reason that the vessel was built on the sea wall, where no permanent ways were possible, and from which she was launched sidewise on temporary ways extending over the sea wall. These ways were designed to tip and drop the vessel off the ends. The tipping of the ways, the angle of the vessel and the enormous splash when the tug hit the water are shown by the photograph.

With an all-steel hull subdivided into twelve watertight compartments, steel superstructure, two pole masts—the forward one being equipped with a cargo boom—together with modern equipment in the way of steam steering gear, steam windlass and towing engines, the *Pocahontas* constitutes an important addition to the auxiliary craft of the navy.

The tug has an overall length of 123 feet 6½ inches, and an extreme beam over guards of 26 feet 7⅞ inches. Her mean draft is approximately 13 feet 3½ inches, with a displacement of 604 tons. The propelling machinery of the vessel is located amidships. Steam is supplied at a working pressure of 200 pounds per square inch by two single-end Scotch boilers arranged fore and aft, the fireroom being fitted for mechanical oil burning exclusively. The main engine is of the inverted-cylinder, triple-expansion, surface-condensing type, of about 800 horsepower. The vessel is particularly well equipped with auxiliary machinery of the latest and most approved design, while the electrical equipment is also thoroughly modern and complete.

A sister ship is being built at the Charleston navy yard, the boilers for which are being constructed at the Norfolk yard.

Launch of Steamship Edgar F. Luckenbach.—The steamer *Edgar F. Luckenbach,* designed by Mr. George Simpson, naval architect, New York, and built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Luckenbach Steamship Company, New York, was launched on March 29. The vessel is 443 feet long overall, 57 feet beam molded, 31 feet 8½ inches load draft on summer freeboard. The deadweight is 12,800 tons, with a total measurement capacity of 675,000 cubic feet. Propulsion is by a triple expansion engine with cylinders 29, 49 and 84 inches diameter by 54 inches stroke, supplied with steam by three single-ended oil-burning boilers. The designed sea speed is 12½ knots. Six other vessels of similar dimensions are building for the Luckenbach Steamship Company at other shipyards on the Atlantic and Pacific coasts.

Geometry of Wide-Bladed Screw Propeller

Correct Method of Drawing Plans of Wide-Bladed Propeller Explained—Why the Eclipse and Straight Line Method Fails

BY NORMAN A. GRAVESON*

The usual method of drawing a propeller is to consider the projection of any of the succeeding radii, marked off on the propeller face, to be an ellipse, and the plan of this ellipse to be the straight line joining the focal point of the ellipse to the end of the minor axis. To enable the reader to see how far this is true, the accompanying sketch, Fig. 1, shows a cylinder around which is wrapped a line representing a screw or helix.

This helix is generated by projecting the radial advance of a point *A* on the edge of the cylinder on to the axial advance lines of the pitch, or, in plainer words, equal angles of rotation of the point *A* on the edge of the cylinder in elevation correspond to equal advances of the pitch in plan, and the points of intersection form a helix.

In the case of the propeller this helix is the plan of the intersection of the propeller blade with the boss, or of any of the radial lines scribed on the face of the propeller blade. When the propeller blade is narrow in width the use of straight lines in the plan does not affect the shape of the projected surface of the blade, as it will be seen that the helix is nearly straight for a small distance on either side of the center.

Referring to Fig. 2, which shows a helix and a straight line meant to be the plan of an ellipse, originate from the same axis, and both of these lines have the same pitch, but the helix is the true plan of a line wrapped round a cylinder to form a screw, whereas the plan of the ellipse is that formed by a line drawn from the focus of the ellipse to the edge of the minor axis. For the same length of blade cross-section the use of straight lines in the plan shows the length of the section in a fore and aft direction to be shorter than the true length shown by the helix. The distance from the focus of the ellipse to the center line is

equal to $\frac{\text{Pitch}}{2\pi}$

It will be seen that for a wide-bladed propeller the sections along the helix, when projected onto the elevation, are not ellipses, but a curve which will have the same minor axis, but a larger major axis. To project this

* Marshall Scholar.

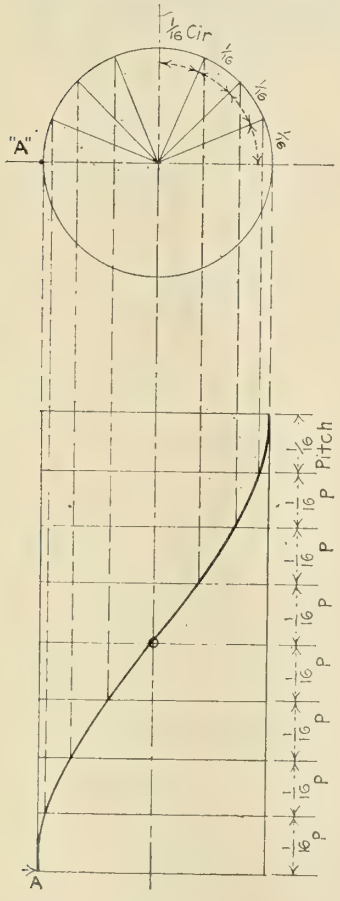


Fig. 1

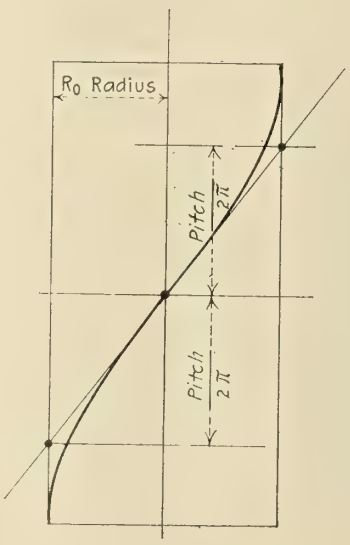


Fig. 2

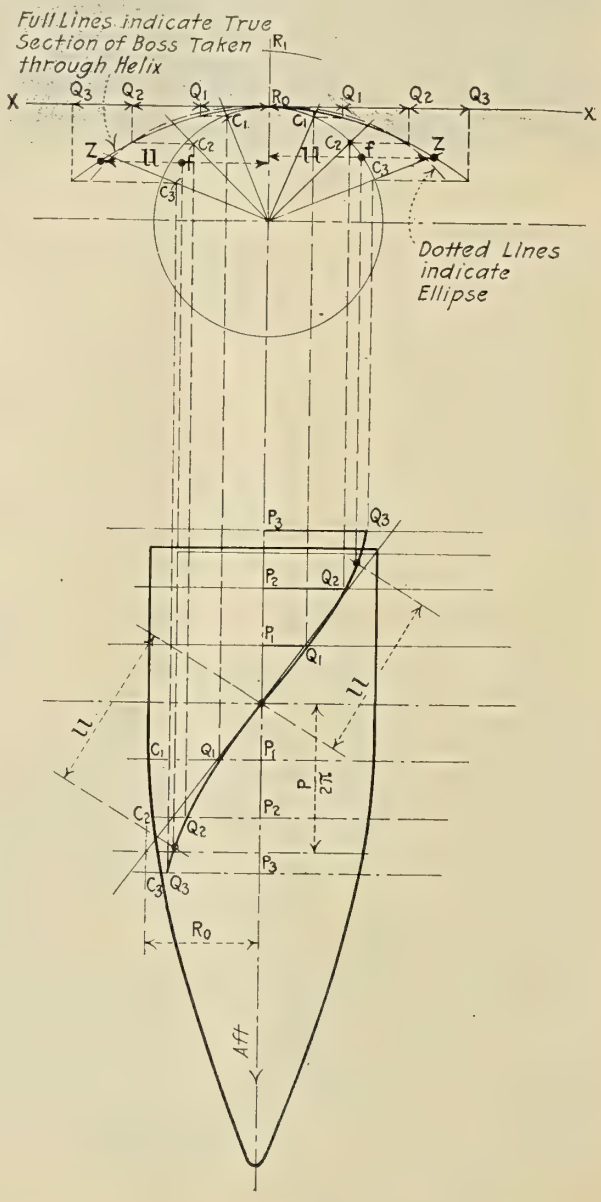


Fig. 3

curve, take as an example a case where the blade root joins the boss and proceed as follows:

Lay off the propeller boss in plan and elevation (Fig. 3). Divide the pitch into 16 equal parts, and, starting from the center line of the propeller in the plan, mark off these increments of pitch in a fore-and-aft direction, as at P_1, P_2, P_3. In the elevation, divide the top half of the circumference of the boss into eight equal parts, as at C_1, C_2, C_3, and drop the *points* C_1, C_2 and C_3 from the elevation onto the lines P_1, P_2 and P_3 in the plan. Join these points and the helix shows the intersection of the blade with the boss in plan.

To develop this curve in the elevation, proceed as follows: Draw a line XX, touching the circumference of the boss at the vertical center line, and on this line, by means of dividers, step off the length of the helix, namely, the portions between each increment of pitch, as Q_1, Q_2, Q_3 in Fig. 3. From these points drop vertical lines to meet horizontal lines produced from C_1, C_2 and C_3. These points when joined form the elevation of the intersection of the blade with the boss. After this, mark off the length chosen for the blade root. When doing this it is policy to take the length of the helix from the forward face to the aft face of the boss to make sure of a strong root section. Then, taking this distance $l\,l$ half the length of blade root (Fig. 3) in the compasses, mark it off from the vertical center line to cut the curve in the elevation at Z. Produce this point horizontally to cut the circumference of the boss at f, and project downwards. This point will be found to lie on the helix at the ends of the blade root.

This now completes the plan and elevation of the curve at the blade root, and by the same process the curves at the radii R_1, R_2, R_3, R_4, R_5 (see Fig. 4) can be drawn, taking care to make the curves long enough to reach the ends of the developed surface of the blade in the elevation, and the helixes in the plan long enough to meet the projections of the curves in the elevation produced downwards.

A good method to use when doing this construction is to take the radius at R_5 (Fig. 4) and divide it into eight equal parts. Join these points on the circumference to the center of the circle, and this eliminates any error due to measuring small arcs off on the small diameter of the boss.

Now lay off the developed surface in the elevation, and where the developed surface cuts the curves formed by projecting the helixes, these points produced to cut the radii R_1, R_2, R_3, R_4 and R_5 give at p_1, p_2, p_3, etc. (Fig. 4) the points which form the edges of the projected surface of one blade. Join the points p_1, p_2, p_3, p_4 and p_5 and the top of the blade, and the shape thus found is the projected surface.

It will be noticed that on Fig. 4 only one-half of the elevation and plan is drawn. The reason for this is that it is easier to construct these halves as shown on Fig. 4 and then trace them on the other side than to do a complete construction straight away, and, again, a certain amount of time is saved in the process.

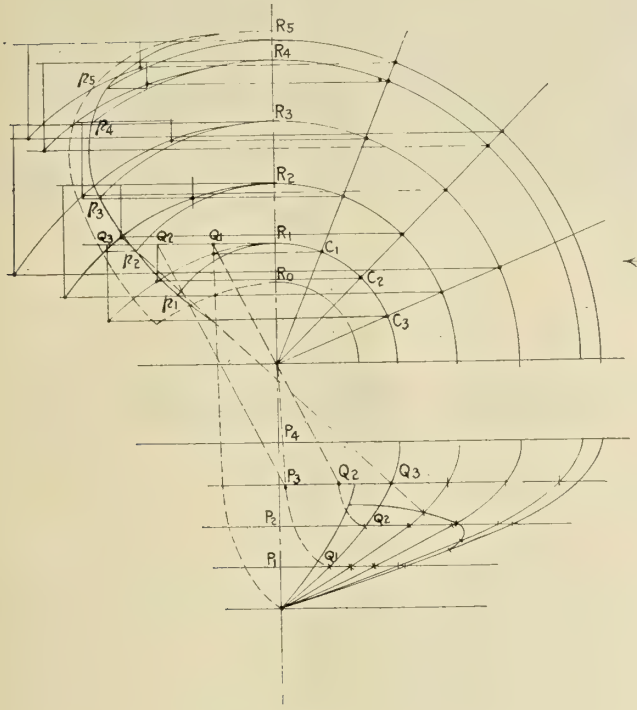


Fig. 4

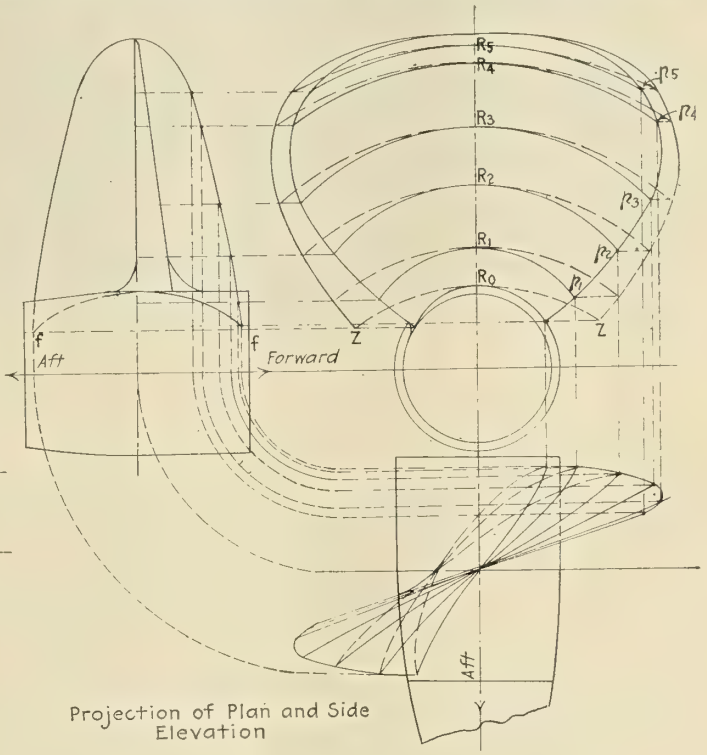


Fig. 5

Plan of Blade

To draw the plan of the blade, project the points p_1, p_2, p_3, p_4 and p_5 vertically downwards to cut the helixes in the plan. This is shown clearly in Fig. 5, and when the points of intersection are joined together the result is the plan of the blade.

When drawing the projected surface and plan of the blade, it is best to draw all the helixes first; then draw the projections of the helixes in the elevation one at a time, projecting down each point on the projected surface separately to cut the corresponding helix in the plan. By doing this the draftsman does not fall into the error of projecting the edges of the projected surface onto the wrong helix.

Side Elevation of Propeller (Fig. 5)

Lay off the side elevation of the boss and draw the vertical center line. Now, dealing with the first radius R_0, this interests the boss at the ends of the developed surface at the points ZZ. Project these points across to the side

elevation of the boss and lay off lines at these heights parallel to the horizontal center line of the boss.

Referring to the plan, the boundaries of the arcs which cut the developed surface are projected across till they intersect the radii R_0, R_1, R_2, etc., and form the outline of the projected surface. Now, these points projected to intersect the helixes in the plan, give the shape of the blade in the plan. Take, with a pair of compasses, the distance from the horizontal center line in the plan to the point on the helix where the edge of the projected surface intersects it, and mark off this distance from the vertical centerline in the side elevation on the line laid off at the height equal to the end of the developed surface, care being taken that the distance on the forward side is laid on the forward side in the side elevation and the aft side on the aft side in the side elevation. These two points *f f*, Fig. 5, are where the blade joins the boss in the side elevation, and if the above process is repeated for each of the succeeding radii R_0 R_1, etc., the side elevation can be completed. But care must be taken that the height at which the points are laid off in the side elevation is where the curve corresponding to the radius cuts the developed surface and not the top of the radius.

The foregoing practically completes the geometry of the wide-bladed screw, and the drawing can be completed to suit the individual taste of each draftsman.

To complete the drawing, in the side elevation mark off the blade thickness at the root and tip; join these and draw the radii where the blade root joins the boss. Take the thickness of the root of the blade at each radii R_0, R_1, R_2, etc., and on the right-hand side of the drawing of the developed surface lay off sections of the blade at each radius, using the blade thickness taken at the radius, the lengths being obtained by stepping out the lengths of each half curve or arc that starts from R_0, R_1, etc., to cut the developed surface.

Plan of the Back of the Blade

In the plan, dot all these blade sections along the edge of the helixes; lay off the thickness at the blade tip, and with a curve join the back edges of the blade sections, and the plan of the blade is complete. The three views of the propeller are now complete, and, to finish the drawing, the detail of the cone nut, gland, wash plate, stop-pins and keys should be given.

The method which has been detailed in the foregoing notes is only advocated for wide-bladed propellers, which, if drawn by the ellipse and straight-line method, are not correct, the projected surface being out of shape, and also the true attachment to the boss being shown smaller than it really is.

Dredge With Geared Turbine-Driven Pumps

First Turbine-Driven Dredge Pump in America Installed on Dredge Columbia in Service at Portland, Ore.

Figs. 1 and 2 show two geared steam turbines driving pumps as developed at Wellsville, N. Y. While direct connection on a steam turbine-driven unit is undoubtedly the best practice under many operating conditions, nevertheless, where steam economy is the first essential, reduction gears not compelled to run at excessive speeds can often be used advantageously to produce the speed and highest efficiency of the driven unit, at the same time permitting the turbine to run at the higher speed which may be demanded for the best steam economy.

It will be seen that the interposition of the gears allows both ends to do their best work, and, since the friction loss

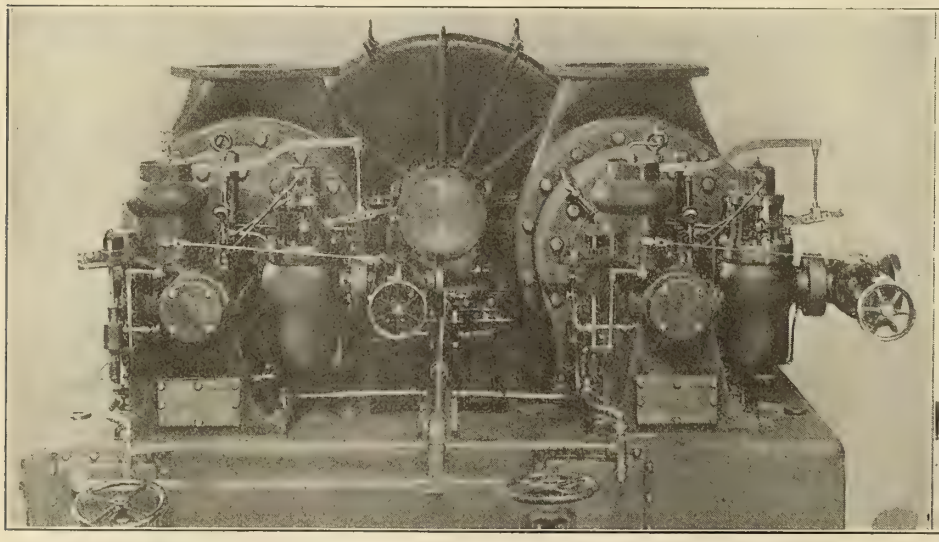


Fig. 1.—End View of Turbines Driving Dredge Pump Through Gearing

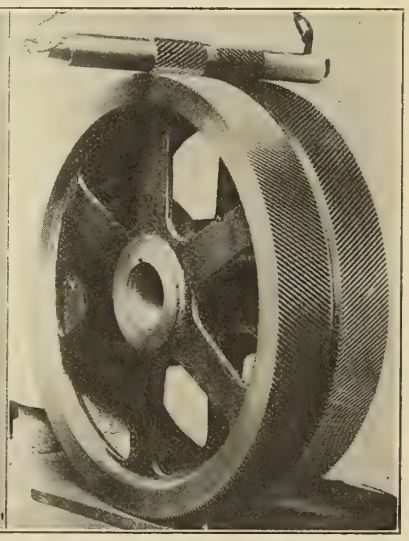


Fig. 2.—Pinion and Gear—Speed Reduction 3,600 to 300 Revolutions Per Minute

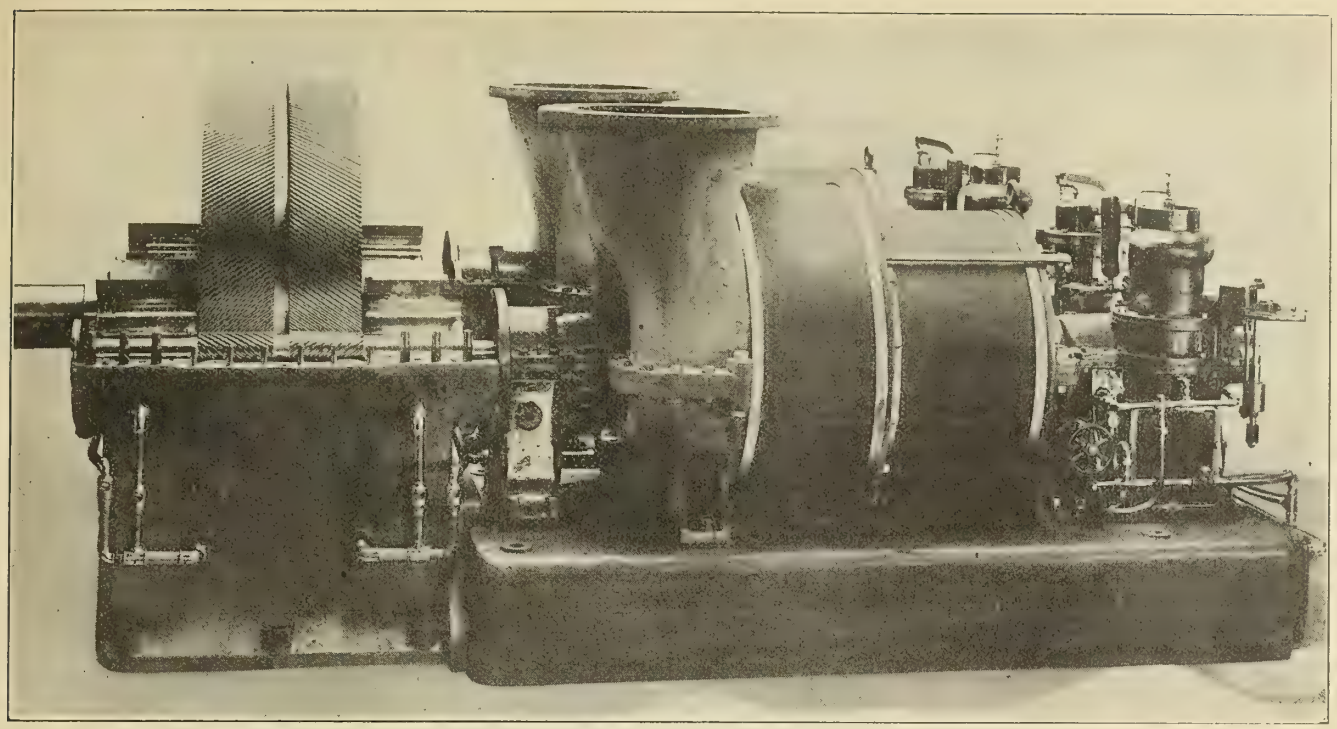


Fig. 3.—Two 1,000-Horsepower Turbines Driving the Pumps on the Dredge *Columbia*

in accurately cut gears is practically negligible, there is an all-around gain. The photographs show two 1,000-horsepower Kerr "Economy" turbines used to drive the pumps on the dredge *Columbia,* of Portland, Ore., through herringbone reduction gears from 3,600 to 300 revolutions per minute, the two turbine pinions meshing with the one gear. This is the first turbine-driven dredge pump ever used in America.

The diagram, Fig. 4, shows test curves of a steam turbine of this type, indicating the relation between speed and horsepower developed, also the steam rates per brake horsepower for different horsepowers and speeds. It will be seen on these test curves, with this particular turbine running at 3,800 revolutions per minute, that the steam rate is but 15 pounds per brake horsepower hour, as against 28 pounds when running at 1,400 revolutions per minute, or, if the turbine had to be slowed down to produce the highest efficiency of a direct-driven unit requiring the latter speed, it would use almost twice as much steam.

It is evident, therefore, that suitable gears, which absorb at the most less than 2 percent of the power in friction, can make an immense saving. Looking at the question the other way, the turbine, while developing 200 horsepower at 3,800 revolutions per minute, develops hardly more than 100 horsepower at the slower speed.

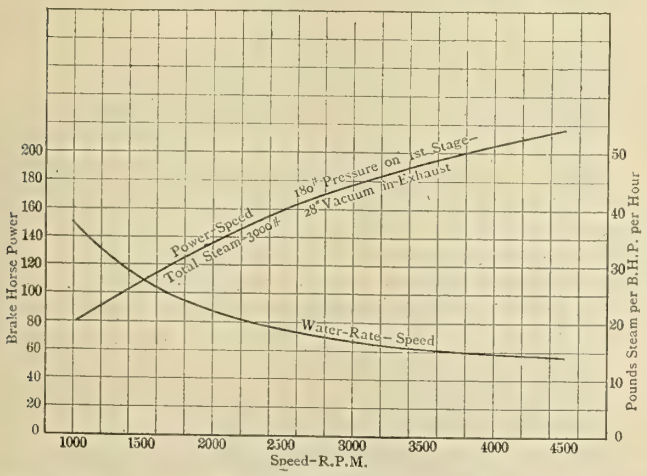


Fig. 4.—Test Curves Showing Relation Between Speed and Horsepower of Turbine

It is claimed that the geared units have had such a thorough trial and have met with such splendid success that, under many conditions, the geared type for driving pumps is most desirable, and also for belt driving from high- or low-pressure turbines. Low-speed, turbine-driven pump units receiving their power through gears are not subject to the detrimental speed compromise characteristic of the direct-driven unit. In municipal and steel mill pumping service the best steam consumption per water horsepower; that is, good duty per 1,000 pounds of dry steam, is essential, and the only way this can be obtained with a turbine is through reduction gears.

In one case where a duty of 115,000,000 foot pounds of work per 1,000 pounds of dry steam, which is equivalent to a steam consumption of 17.8 pounds per water horsepower, was obtainable from a geared turbine, but a direct-connected unit would have produced only 87,000,000 foot pounds maximum or a steam consumption of 25 pounds per water horsepower. As another instance, an 8,000,000-gallon-per-day, gear-driven turbine pump runs at 1,200 revolutions per minute and the driving turbine at 3,600 revolutions per minute. The use of the gears here made it possible to obtain a steam consumption of practically 22 pounds per water horsepower with 27 inches of vacuum, while with a direct-connected unit the steam rate would have been about 28 pounds.

German Ships Interned in United States Ports.—According to information compiled by the *Journal of Commerce,* 65 German vessels, aggregating 488,368 tons, and 12 Austrian vessels, aggregating 56,713 gross tons, are now interned at various American ports. Out of the total number of 65 German ships, no less than 28 with an aggregate gross tonnage of 304,545 are at the port of New York, 8 at Honolulu, 7 at Boston, 3 at Baltimore, 3 at New Orleans, 2 at Philadelphia, and the balance scattered among various other ports.

Calculations for Ship's Forms*

Discussion of the Theory of Rolling of Ships —Practical Results From Model Experiments

BY REAR ADMIRAL D. W. TAYLOR †

The matter of rolling is thrust upon the attention of all who have to do with ships. Of late years there has been a recrudescence of interest in this important subject, and the investigations made of it, instead of being of academic interest only, as had mainly been the case formerly, are of great practical interest and value. Model experiments have been resorted to in case of Russo's Navipendulum[2] and with the apparatus devised originally by Biles.[3] Schlick ‡ some years ago and Sperry § more recently have actually checked rolling by gyroscopes, and Frahm ** water tanks for the same purpose have recently been brought forward and installed in a number of vessels.

Those who investigate the literature on the subject will find little or nothing of practical value before the wonderful paper contributed by William Froude to the Institution of Naval Architects in 1861.††

In this paper, Froude laid down the underlying principles affecting rolling, particularly unresisted rolling, and, although there were soon other workers in this field, it may be said that the theory of rolling, as accepted to-day, is practically the theory developed by William Froude in his paper of 1861 and in his later writings on the subject. Perhaps the most important practical result of Froude's early work was the demonstration of the fact that if we wish to reduce rolling, particularly in large ships, we should reduce the metacentric height and lengthen the period of the ship. Formerly it had been generally thought that the greater the stability the less the rolling. Froude assumed at first that a ship broadside to regular waves of uniform period tended, at any instant, to set herself perpendicular to the disturbed water surface, and that the amount of this tendency was measured by the angle between the actual position of the mast of the ship and the normal to the wave surface. Subsequently he substituted for the wave surface what he called the "effective" wave surface, which he took to be the surface of equal pressure passing through the center of buoyancy of the ship. The voluminous work of Froude and his successors on the theory of rolling in the trough of a wave may almost be summarized in a single equation, which is a modified form of an equation given by Lloyd Woollard, Esq.,[4] in a paper before the summer meeting of the Institution of Naval Architects in 1913.

Let θ denote the angle of inclination of the vessel at any time, t, measured in seconds from an arbitrary time of starting, or zero of time. Let P denote the natural period of unresisted rolling of the ship in still water, which is expressed with close approximation by the formula

$$P \frac{2\pi\rho}{\sqrt{gm}},$$

where ρ is the radius of gyration of the vessel about its center of gravity, m is the metacentric height and g is the acceleration due to gravity. P is the complete or cyclic period of the double roll. Let P_w denote the natural period of the wave. Let e be the base of hyperbolic logarithms. Let a be the maximum slope of the wave affecting the ship—not the surface slope, but the virtual slope. Let C be the coefficient of resistance to rolling of the ship, the resistance being assumed to vary as the first power of the angular velocity, and let B and β be arbitrary coefficients depending upon the initial circumstances of motion. Then we have

$$\theta = Be^{-C\frac{2\pi t}{P}} \sin\left\{\frac{2\pi t}{P}\sqrt{1-C^2}+\beta\right\} + a\frac{P_w^2}{\sqrt{(P^2-P_w^2)^2+4C^2P^2P_w^2}} \sin\left(\frac{2\pi t}{P_w}-\tan^{-1}\frac{2CPP_w}{P_w^2-P^2}\right)$$

When $a = O$ and C has a value, or there is resistance to rolling, we have the case of resisted rolling in still water, which, as is obvious from the equation, is soon extinguished. When a has a value and $C = O$, the rolling is unresisted in uniform waves. In this case

$$e^{-C\frac{2\pi t}{P}}$$

is equal to unity and θ is the result of two superposed rolls, one a free roll, so called, of maximum amplitude, B, and period P, and the other a forced roll of maximum amplitude

$$a\frac{P_w^2}{P^2-P_w^2}$$

and period P_w, or the *period of the wave.*

In practice, C is quite small, but not negligible, so we would expect to find a ship in the trough of the sea soon rolling in the period of the wave, as prescribed by the second term. The formula was deduced upon the assumption that resistance to rolling varies as the first power of the angular velocity of rolling. While this assumption may be justified, if we properly choose C and deal with small rolling only, it is far from being exact. More than forty years ago there was an extended discussion on this question betwen Mr. William Froude and M. Emile Bertin, in *Naval Science* and elsewhere. Mr. Froude maintained that resistance to rolling was properly expressed by two terms, one, the more important, varying as the first power, and the other as the square of the angular velocity of rolling. M. Bertin stoutly maintained then, and to this day, that

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* From a paper presented at the International Engineering Congress, San Francisco, Cal., September, 1915. (For previous installments see October, 1915, and February, 1916, issues.)

† Chief Constructor, United States Navy.

2 "An Experimental Method of Ascertaining the Rolling of Ships on Waves," Captain G. Russo, Transactions of the Institution of Naval Architects, 1900.

3 "Experimental Determination of the Effect of Internal Loose Water upon the Rolling of a Ship Amongst a Regular Series of Waves," A. Cannon, Transactions of the Institution of Naval Architects, 1913, Part II.

‡ "Experiments with Dr. Schlick's Gyroscopic Apparatus for Steadying Ships," Sir Wm. H. White, Transactions of the Institution of Naval Architects, 1907.

§ "Active Type of Stabilizing Gyro," E. A. Sperry, Transactions of the Society of Naval Architects and Marine Engineers, 1912.

** "Neuartige Schlingertanks zur Abdampfung von Schiffsrollbewegungen und ihre erfolgreiche Anwendung in der Praxis," H. Frahm, Jahrbuch der Schiffbautechnischen Gesellschaft, 1911.

†† "The Rolling of Ships," William Froude, Transactions of the Institution of Naval Architects, 1861.

4 "The Effect of Water Chambers on the Rolling of Ships," Lloyd Woollard, Transactions of the Institution of Naval Architects, 1913, Part II

resistance to rolling should vary as the square of the angular velocity. I will give later results of some model investigations in this connection, but perhaps for the reason that C is small compared with the other quantities involved, the above expression for forced roll, regardless of the original assumption involved, is undoubtedly practically exact under the circumstances assumed, of uniformity of sea and known effective slope.

If we take a pendulum mounted so as to have resistance to oscillation and give it harmonic impulses of a period different from its natural period, and of strength corresponding to an angle a in the formula, the pendulum very soon sets up forced oscillations of the period of the impulses, and until the resistance to the motion of the pendulum is relatively much greater than the resistance to rolling of a ship, the amplitude of these uniform forced oscillations will be almost exactly that derived from the formula above.

The formula has also been checked as to period by a number of experiments with models in uniform waves at the United States Model Basin. It is remarkable how models, whether with or without bilge keels, when in the trough of a series of uniform waves, will promptly fall into step and oscillate in consonance with waves whose periods vary from ¼ to 1½ times the natural period of the model. That there is a practical limit to this, however, is indicated by model experiments. For instance, a wave whose period is only from ¼ to ½ the natural period of the ship will not induce forced rolling in the latter unless it has a certain height. Waves that are low as well as short have little or no effect, as might be expected.

Since experiment confirms so fully the formula above, it might seem at first sight that it is, in theory, a complete solution of rolling problems. As a matter of fact, it is far from this, for the simple reason that it assumes uniform isochronous known impulses from the waves. While the sea has infinite variety and will at times give uniform isochronous impulses, this is a rare occurrence. In an ordinary sea, successive waves vary materially in height and period. The net result is that the free-rolling term in the formula does not disappear. We may express this result in *quasi* mathematical fashion by saying that, instead of measuring t from one initial condition, we are constantly taking a fresh start, and that with each fresh start, B, β, a and P_w are changed in an unknown manner to suit the initial conditions.

Fig. 1 is an actual rolling record from a large battleship in a rough sea, and is fairly typical of the usual rolling of a large ship. The irregularity of the rolling is obvious upon inspection. We note in Fig. 1, as the most conspicuous feature, that periods of maximum rolling alternate with periods of comparative quiescence. This is typical of theoretical, unresisted rolling in a series of waves whose period differs from the period of the ship, but, in the latter case, the alternations as shown by the formula are systematic and regular, while in actual rolling they are neither. If we could estimate accurately the forced rolling of a given ship in a given uniform sea we could be certain that the maximum angle of actual roll would not be as much as twice the angle of forced roll. For if we had the ship in step with the sea and doing forced rolling, the worst that could happen would be for the phase of the sea to suddenly shift, so that the forced roll became a free roll and a new forced roll of the same amount would grow up, being superposed upon the decreasing free roll. Evidently the combination of the decreasing free roll and increasing forced roll could never exceed the maximum forced roll.

Unfortunately, as to one of the most important factors in the forced-rolling term—namely, a—we have very little real knowledge. Froude started with the natural assumption that a was the maximum surface slope of the wave. He soon found, however, that, in practice, ships and models did not roll so much as would follow from this assumption, and consequently took for a the maximum slope of the surface of equal pressure at the depth of the center of buoyancy below the surface. There are some indications in Froude's latest writings on this subject that he regards even this reduced value of a as perhaps too large. The matter is one of much practical importance for several reasons:

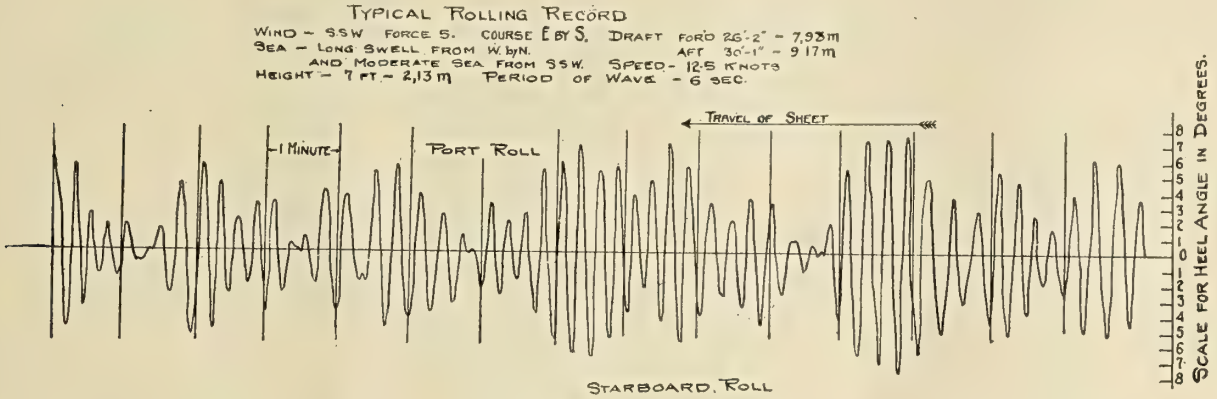

TYPICAL ROLLING RECORD
WIND – SSW FORCE 5. COURSE E BY S. DRAFT FORD 26'-2" – 7,98m
SEA – LONG SWELL FROM W. byN. AFT 30'-1" – 9.17m
AND MODERATE SEA FROM SSW. SPEED – 12·5 KNOTS
HEIGHT – 7 FT. – 2,13m PERIOD OF WAVE – 6 SEC.
TRAVEL OF SHEET
1 MINUTE
PORT ROLL
STARBOARD ROLL
SCALE FOR HEEL ANGLE IN DEGREES.

Fig. 1

1. Heavy rolling of ships is always mainly forced rolling. When there is approximate synchronism of the wave impulses with the natural period of the ship, she approaches rapidly the maximum forced roll, which, neglecting resistance, is

$$a \frac{P_w^2}{P^2 - P_w^2}.$$

The greater the natural value of a the more rapidly the roll grows, and the greater the range of wave period over which dangerous rolling may be set up.

2. In practice, when there is approximate synchronism, ships would promptly capsize in a regular sea were it not for the fact that the natural increment of roll due to the passage of a wave is neutralized by the natural decrement of roll due to the resistance of the ship to rolling while the wave passes. The greater the value of a the greater the rolling angle to produce an equal decrement.

3. When one undertakes to stop rolling by a gyroscopic or other mechanical device it is very desirable to know how much roll a given wave will communicate to a given

ship. Only when this is known do we know how much of a sea we have provided against with our apparatus.

It might seem at first sight as if observations of rolling on actual ships would give the information desired. While extensive observations of this nature would be of much help (they seem very difficult to obtain and are painfully rare), they would not fully meet the need, for the reason that increment of roll due to the passage of a given wave might, in the case of a rolling ship, be very much greater or very much less than if the ship had been originally upright at rest. It is the increment in the latter condition that we need to know in connection with apparatus to hold the ship upright.

Some investigations at the United States Model Basin, of the rolling of models, while not conclusive, indicate strongly the need for developing the theory of rolling beyond the condition in which it was left by Froude. Such model investigations are by no means easy. One great difficulty is in connection with the waves. It is, of course, easy to produce waves of uniform length, but waves advancing in a canal of limited width, although looking very uniform to the eye, when carefully investigated seem to vary in height in a very puzzling fashion. The model experiments referred to seem to indicate that not only the metacentric height, but the absolute height of the center of gravity influenced the rolling behavior.

This is upon consideration just what might be expected. Consider a ship in the trough of the sea. She is acted upon by the reactions of the water which may be regarded as an infinite number of transverse forces. These can be reduced to a single resultant, and we know from the elementary principles of mechanics that the center of gravity will move as if the resultant were exerted through it, while there will be a movement of rotation due to the leverage of the resultant about the center of gravity. This is altogether independent of any question of metacentric height. We know as a matter of fact that under such circumstances the center of gravity of the ship has an orbital motion. Fig. 2 gives actual paths of the center of gravity of a model 20 feet by 3.436 feet by 0.970 foot by 2,500 pounds displacement in waves of the length and height indicated. These orbits are elliptical, probably because the waves are of the shallow-water type when the water particles traverse elliptical orbits. For deep-water waves the orbits would have been nearly circular. From the orbital path it would be possible to deduce the acceleration at any point and hence the corresponding forces. Also, if the angular motion were carefully determined, we could, by analysis, deduce the positions or lines of action of the resultant forces. While experiments hitherto made are not of such order of accuracy as to allow this to be done, it may be pointed out that the orbital path of the center of gravity in deep-water waves is roughly circular, indicating that the actual resultant unbalanced forces are harmonic in their nature. If we take a vessel at the steepest part of the wave, when she is moving vertically in her orbit, the acceleration of the center of gravity is horizontal, so that if the ship is vertical at the instant, the resultant force acting upon her is horizontal.

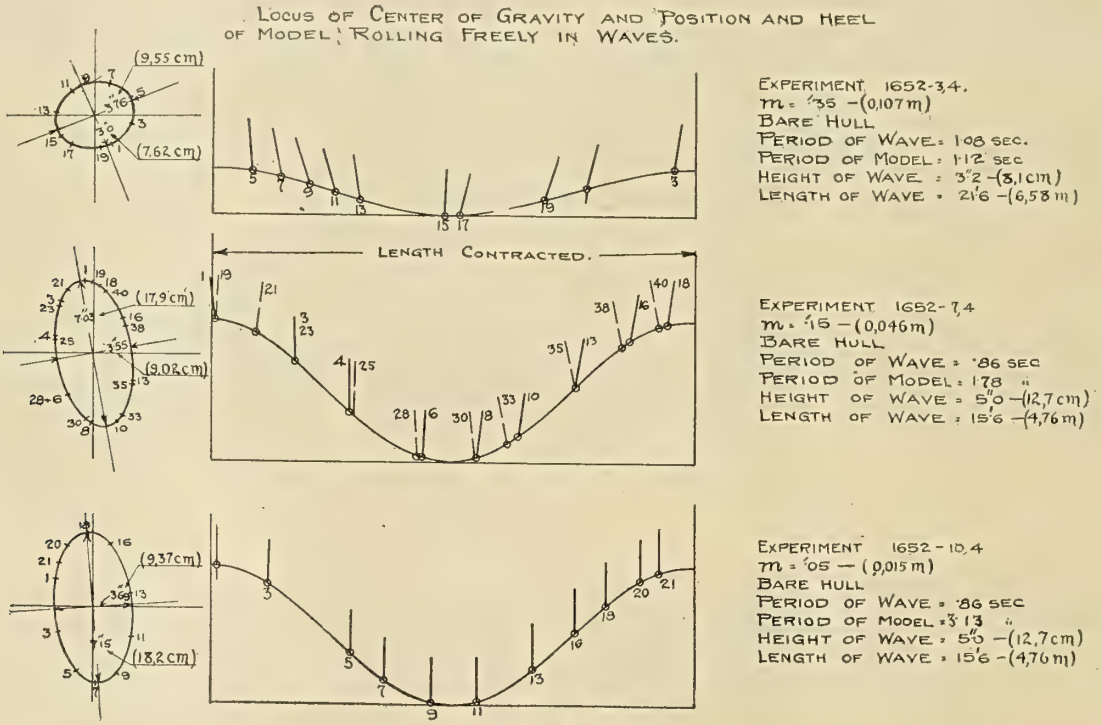

Locus of Center of Gravity and Position and Heel of Model Rolling Freely in Waves.
(9,55 cm)
(7,62 cm)
Experiment 1652-3,4.
m = ·35 —(0,107 m)
Bare Hull
Period of Wave = 1·08 sec.
Period of Model = 1·12 sec
Height of Wave = 3"2 —(8,1 cm)
Length of Wave = 21'6 —(6,58 m)
Length Contracted.
(17,9 cm)
(9,08 cm)
Experiment 1652-7,4
m = ·15 —(0,046 m)
Bare Hull
Period of Wave = ·86 sec
Period of Model = 1·78 "
Height of Wave = 5"0 —(12,7 cm)
Length of Wave = 15'6 —(4,76 m)
(9,37 cm)
(13,2 cm)
Experiment 1652-10,4
m = ·05 — (0,015 m)
Bare Hull
Period of Wave = ·86 sec
Period of Model = 3·13 "
Height of Wave = 5"0 —(12,7 cm)
Length of Wave = 15'6 —(4,76 m)

Fig. 2

If this resultant force should pass below the center of gravity, instead of above, the ship would actually tend to roll toward the wave instead of away from it. In practice it would seem that for most ships the resultant is not far from the metacenter. Froude's theory seems virtually to assume that the resultant passes always through the metacenter. It is quite possible, however, that, particularly when the ship is specially shaped with this in view, the resultant will really pass below the metacenter. This would account for the fact that reduction in metacentric height appears often to reduce rolling more than can be accounted for by the change in metacentric height alone.

It is not likely that the actual wave forces upon a ship have a single point through which they pass. The resultant force will cut the axis at varying distances above the center of gravity as a wave passes, and there will also be variations in this respect as the waves vary and as the ship rolls. But it is obvious that the closer to the center of gravity the line of the resultant force due to a wave, the less the rolling, and that this fact should not be ignored in shaping vessels.

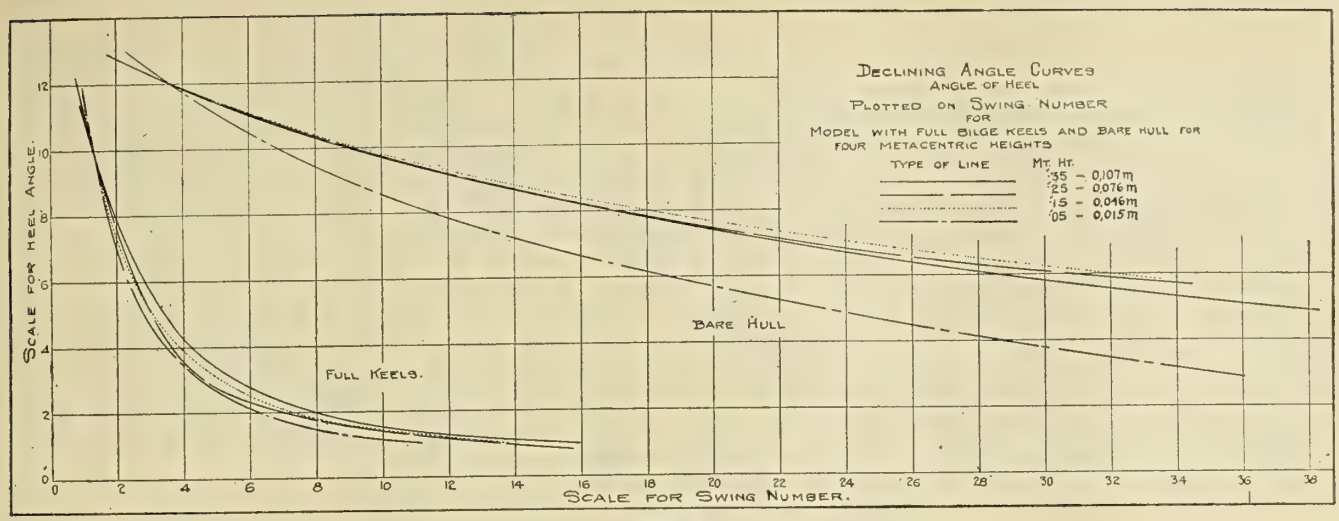


Fig. 3

In Fig. 2 we see that as the metacentric height of the model is reduced from 0.35 foot to 0.05 foot the rolling is markedly reduced, the model in the latter case remaining practically upright, though the center of gravity describes an elliptical path which shows a considerable bodily motion of the model. In this case it appears that the resultant of the external forces acted very close to the center of gravity and the metacenter.

The diagram for the 0.15-foot metacentric height refers to a somewhat disquieting occurrence. The natural period of the ship was about twice that of the wave, and there is rather heavy rolling in the natural period. Large ships are much more likely to encounter steep waves of half their period than of their full period, and if half-period waves can produce rolling effects similar to those of synchronous waves, dangerous rolling is apt to be caused by them. But even with the accurate adjustment possible with artificial waves, this heavy rolling from half-period waves was not easily produced; so with the nearly always irregular waves of the sea, the danger of heavy rolling from half-period waves is probably remote. Still it exists.

I have referred already to the difference of opinion between Mr. Froude and M. Bertin as to the power of the angular velocity with which the resistance of the ship to rolling in still water varies. For such rolling a large number of accurate declining-angle curves of models have been obtained at the United States Model Basin, usually from an angle of 15 degrees or so; and these have been analyzed. It was found that the nature of these declining-angle curves was such that they did not satisfactorily agree with either Froude's theory or Bertin's theory. Any particular curve could, however, be represented quite well, and many of them almost exactly, on the assumption that the resistance to rolling at any instant varied as a coefficient into some fractional power of the angular velocity. Unfortunately, this fractional power varied somewhat inconsistently, although in many cases it seems to be very close to 1.5. The limits, however, appear to be fairly well defined. In no case tested did the resistance to rolling vary as a power of the angular velocity greater than 2 or less than 1. When rolling in still water, the center about which the ship revolves is, in practically every case, between the center of gravity and the waterline; that is, when the center of gravity is below the waterline, this center was above the center of gravity, and when the center of gravity was above the waterline this quiescent center was below the center of gravity. It did not appear, however, that this center remained in quite the same position throughout the roll.

We know in theory that for unresisted rolling in still water the period is given by the following formula:

$$P = \frac{2\pi\rho}{\sqrt{gm}}$$

where P is the complete or cyclic period of roll in seconds, ρ is the radius of gyration of the vessel about its center of gravity, m is metacentric height, and g is acceleration due to gravity.

For ordinary ships, although we frequently know the metacentric height, the radius of gyration is not known, so the formula is not of much practical value; but it is more or less used, in practice, to arrive at the radius of gyration from observations of the rolling period in still water. But, since actual rolling is resisted, there is some question as to the accuracy of the values of ρ so determined.

A number of the models tried at the Experimental Model Basin were carefully weighted and inclined in order to determine their metacentric height, and also swung in a hanging cradle in order to enable their radii of gyration, as weighted, to be determined. The dimensions of three of these models are as follows:

Model Number	Length, Feet	Breadth at L.W.L. Feet	Draft, Feet	Displacement, Pounds	Transverse Metacenter, Feet
1650.....	20.0	2.926	1.139	2,500	at L.W.L.
1651.....	20.0	3.193	1.044	2,500	0.2 ft. above L.W.L.
1652.....	20.0	3.436	0.970	2,500	0.4 ft. above L.W.L.

Each model was tried with exceptionally large keels, 1.8 inches, or some 15 percent of the draft, in depth, and 10 feet long on each side; also, with the middle third of the keels removed, and with all of the bilge-keels removed. Four metacentric heights were used, ranging from a very small metacentric height of 0.044, the draft of the vessel, to a very large one of about 0.36 of the draft. In the following table will be found the theoretical period of unresisted swing of each model in each condition, calculated from the formula at the top of the next page.

TIME IN SECONDS FOR ONE SWING OR ½ PERIOD

Model No.	Bilge Keels	1650 Observed	1650 Calculated	1651 Observed	1651 Calculated	1652 Observed	1652 Calculated
GM—0.35 feet.	Full	.94		1.12		1.17	
	⅓ off	.95	.954	1.10	1.040	1.15	1.100
	none	.94		1.05		1.12	
GM—0.25 feet.	full	1.21		1.36		1.41	
	⅓ off	1.18	1.130	1.34	1.274	1.41	1.338
	none	1.16		1.29		1.34	
GM—0.15 feet.	full	1.63		1.78		1.87	
	⅓ off	1.61	1.505	1.75	1.678	1.86	1.763
	none	1.53		1.67		1.79	
GM—0.05 feet.	full	2.94		3.27		3.36	
	⅓ off	2.89	2.740	3.20	2.996	3.33	3.083
	none	2.83		2.96		3.13	

$$\frac{P}{2} = \frac{\pi \rho}{\sqrt{gm}},$$

and the actual swing period as observed in careful rolling trials in still water.

It will be seen that the actual periods are remarkably close to the theoretical periods, and that the effect of the excessively large bilge keels upon the period is not great. It would seem, then, that we could rely upon the radii of gyration of actual ships, as determined by rolling experiments, with a good deal of confidence.

Incidentally, it is interesting to note that the declining-angle curves varied remarkably little with metacentric height. Thus, Fig. 3 shows eight declining-angle curves for model No. 1652, four being with bare hull and metacentric heights ranging from 0.05 foot to 0.35 foot, and the other four being with full bilge-keels and the same metacentric heights. It should be remembered that these declining-angle curves are plotted upon roll numbers and not upon time. The vessel of large metacentric height, rolling more quickly than the vessel of small metacentric height, would have a given roll extinguished in less time, but it would take about the same number of rolls as for the vessel of small metacentric height.

Voltaic Corrosion and Prevention

BY THOMAS J. ROGERS

Numerous methods have been suggested and employed for the protection of those parts of a ship's fittings which come in contact with sea water, among which zinc has been extensively used for this purpose from its electro-positive character. The influence of this metal in protecting another which is negative to it and under the salt solution, is a subject that has occupied the attention of practical men for a long time. It is one of very great importance at the present time, as corrosion takes place to an alarming extent on those fittings which have to conduct sea water to the various points in the modern steamship. To protect these fittings, many experiments have been tried, and no appreciable results have been obtained. The highest engineering skill has been employed, but nevertheless there seems to be a great deficiency in the knowledge of the extent of this influence and how and when it is most effective. The frequent corrosion of condenser tubes, of the pipes used as salt water conductors and of the sundry fittings which comprise the salt water system of the modern "leviathan of the deep," is abundant proof of this deficiency, either in the manner of application or in the method employed.

From a careful observation of salt water pipes which have been repaired or renewed under the author's supervision, he is convinced that the excessive pitting is due to a gas, or a combination of gases, and that wherever a zinc plate or ring has been placed in the neighborhood of these fittings to prevent galvanic action, the pipes are always severely pitted at the top part of the inner surface as they are placed in the ship, and that their length of service is very short in comparison to those which have not been placed under the influence of this metal, as in the manner herein described.

The method employed to prevent galvanic action to plating of hull adjacent to the openings of sea valves is to fit a cast zinc ring in the apertures of supply and discharge pipes below the water line. This arrangement under the most favorable conditions is only a partial protection, which will induce a more negative state to the metals in proximity of the zinc and render those parts farther distant more positive. Such a diversity of conditions will give rise to voltaic action between the extremities, and from this inequality of protection it is productive of numerous evils which, when arising in one locality, may become contagious and affect the whole surface exposed to this influence. It can be readily imagined that the zinc ring has, from the manner in which it is secured, a metallic contact with the lip of the composition stool which pierces the hull. A pair of metals so arranged will not be able to generate much current and the conditions are such that it is not applicable for the purposes for which it is intended, as the conducting powers of the composition and copper connections are so much superior to the salt water and the plating of the hull that whatever of current is excited will find the easiest passage through the fittings, and as there is no electric effort in the direction of the plating, it being a positive metal in this series, will be given a more positive value in the solution.

It is a well-known fact to electro-chemists that when copper and zinc or composition, and copper and steel and zinc, as in this case, are placed in a salt solution, they form a single fluid battery with two parts of metals, and no battery of this order will generate or maintain an electric current of a uniform constancy of strength to protect the metal from dissolution by galvanic action, as the surfaces of the positive metals soon become decomposed in their order and the negative metals, by becoming polarized from the gradual accumulation of hydrogen gas upon their surfaces, become insulated and give a counter effect in the solution.

In applying this principle as a means of protection there are other elements which have not been taken into consideration. There are possibilities of the electro-chemical action at these points setting free many elements contained in sea water which are injurious to a ship's fittings. In the action between the sea water and the metals hydrogen gas is evolved. This gas alone is harmless, but there are cases in which it enters into combintion with other elements and dissolves those metals which have an affinity for it. Hydrogen, when in the act of being evolved by the agency of a metal, manifests sufficient activity to decompose other existing combinations present in the water and appropriate their elements, thus forming new compounds. It is well known to chemists that when a current of electricity is passed through a salt solution the salt contained in the solution will become decomposed, caustic soda being set free from one point, and chlorine from the other point, of the terminals. Chlorine alone acts with great energy upon most substances, disintegrating them and forming new compounds. It has a chemical affinity for hydrogen gas, and under favorable conditions will combine and form one of the greatest solvents known.

From the location of the apertures in the hull of a vessel, and the specific gravity of these gases, they are compelled to arise and pass through the system of pipes when the valves are open, and when closed to escape to the surface water along the outer skin of the hull. From the great tenuity of these gases they have a great penetrative or rapid diffusive power; many metals are penetrated through their pores, and when there is an adhesive attraction or a feeble chemical affinity between them and the metal, they will condense on its surface or in its pores. Eventually these gases find their way into the boilers through the feed pumps which have sea connections through the salt water "make-up" at the condensers, or through the packing of tubes in condenser heads, which it is very difficult to keep perfectly tight, and which in some cases are even allowed to leak to make up the deficiency of feed water. By this questionable method of engineering considerable of this gas finds its way into the condensers, the bubbles of gas in traveling

along with the circulating water through the tubes, becoming trapped in the ferrules, and with the assistance of the vacuum on the steam side and the pressure of the circulating water on the other, it is forced into the condenser, carried down with the condensed vapor, and dissolved into the feed water. From the continual inflow of this gas, the feed water becomes highly charged with it, and those metals in the circuit for which these gases have a liking are readily disintegrated. Copper in its free state is a preventative of crustacean or other marine growth, but under existing circumstances, from the increased negativeness of the fittings in proximity of the zinc, they grow abundantly upon the inner surface of the fittings for a distance of six feet from the aperture and to such an extent as to reduce the area considerably. Beyond this zone of marine growth corrosion of the copper connection commences and continues throughout the system as far as the gases reach, and the greater the distance from the zinc the coarser is the pitting, demonstrating that one point is protected at the expense of another.

The author has seen some specimens of corroded copper tube selected promiscuously from a defective salt water system, and cut open at the bottom of the pipe to show the extent of the corrosion from the gases which traveled along with the water. The bottom and sides of this system of pipes were free from pits and showed a uniform wear from the friction of the water and the action of the salt, but were good for several years' service, although the extent of the corrosion made it economical to renew the sections so affected. The length of service of these fittings was nine months, but with the thickness of metal used it should, under fair conditions, have given at least the same number of years' service. This corrosion is often attributed to imperfections in the metals, but allowing such to be the case, it is impossible for a mechanic in making and installing a system of pipes to get the imperfect parts of a tube, or sheet from which the pipe may be made, always at the top.

If the practice of placing zinc rings in the openings before referred to, as a means of preventing galvanic action at these points, is continued it might be advisable to fit gas chambers on the top parts of connecting pipes at, or as near as possible to, the sea valve to trap the gases as they are evolved, and lead small pipes from the tops of the chambers to and through the hull above the waterline to release them. Similar pipes should also be led from the top of both ends of the condensers to release the gas trapped in the covers, which will thus also insure a solid flow of circulating water and improve the efficiency of the condensers. The composition fittings which pierce the hull below the waterline might be coated with an enamel paint or porcelain that is impervious to sea water, so that when the sea valves are closed there will be no action between these fittings and the plating of the hull.

Important Development in Life Saving Equipment.—The recent approval by the United States Steamboat Inspection Service of the new universal Ilanasilk types of life preservers, invented by Lieutenant S. P. Edmonds, United States Coast Guard, retired, of Newark, N. J., marks an important event in the development of life saving equipment for use on vessels of all kinds. These life preservers were officially adopted by the United States Navy about two years ago after extensive tests and demonstrations of efficiency in actual use on naval vessels. They have also been adopted by the British and Canadian governments for all types of vessels. The equipment includes ship life preservers, pillow life preservers, safety mattresses, boat cushions and swimming floats.

The American Bureau of Shipping

One of the most vital questions affecting the future growth of the American merchant marine and shipbuilding industries is the maintenance of an influential, independent American classification society for merchant vessels. That this question is being brought to a successful issue is shown by the complete reorganization of the American Bureau of Shipping under the guidance of Mr. Stevenson Taylor, president of the American Society of Naval Architects and Marine Engineers, who has recently been elected president of the Bureau of Shipping. Through his efforts and the universal support accorded to him by the various American shipping interests, the American Bureau of Shipping is now well on its way to become a highly efficient technical organization which not only can be used to focus the opinions and aims of those directly interested in mercantile tonnage, but also will command the respect both at home and abroad due to the American merchant marine.

Hitherto the major portion of the classification of American tonnage has been carried out by local representatives of foreign classification societies. Lloyd's Register of Shipping, the premier classification society in Great Britain, which has shared extensively in this work, has only recently been endeavoring to form a separate committee in the United States. Such a combination, however, it is believed, could not be truly international, but would be essentially a British organization with local representation, as the actual control of the classification work of Lloyd's, including the rules for shipbuilding, the appointment of surveyors and the organization in the United States, would still rest in the hands of Lloyd's Central Committee in London, all of which is clearly defined in the society's regulations governing such a committee. Furthermore, such a step would mean that characters assigned to vessels by an American committee of Lloyd's would have to conform or would be subject to alteration by the society's general committee in London. Certificates of classification could not be issued by any local committee.

Opposition to such a local committee of a foreign classification society in the United States indicates a pronounced national feeling on the part of the various American shipbuilding and shipping interests, and it is felt that there will be no difficulty in maintaining a highly efficient classification society wholly American in character and standing. The true interpretation of international classification must necessarily mean national societies working under an international agreement rather than a foreign society with local national representation.

The lack of a national classification society will inevitably lead to government control in the design and construction of vessels, and it is generally felt that such control is not desirable, in that it may be arbitrary and tend to check enterprise and mechanical and commercial progress. Other maritime countries have their departmental bureaus, such as the Board of Trade in Great Britain, the See-Berufgenossenschaft in Germany, and others, but in these instances the actual control, so far as affecting the construction of vessels is concerned, is in effect left in the hands of the national classification societies, who also are empowered by their representative governments to carry out the requirements of loadline regulations. These societies have won the respect of their national legislative bodies as far as their merchant shipping is concerned, and the legislative bodies of these countries are largely guided by the advice and experience of these national societies. With active control representative of the underwriting, shipowning and shipbuilding interests of the United

States, and with a technical staff which has inspired the confidence of these interests, the American Bureau of Shipping will be in a position to place its claims before the United States government for national recognition.

The appointment of Mr. Norman E. McClelland as chief surveyor of the American Bureau of Shipping marks an important advance to meet this strong and insistent demand for an American classification society which shall be organized and administered on broad lines of efficient progressive business and technical ability. Mr. McClelland was born in 1876 and received his early training as a naval architect in the shipyard of Harland & Wolf, Belfast, Ireland, where he passed through the various departments in the yard and completed a five-years' apprenticeship in the drawing office. A few months after completing his apprenticeship, Mr. McClelland was appointed manager of the company's north yard, and for some years was associated in the construction of the famous White Star and other large transatlantic liners built by this firm. In 1899 Mr. McClelland was appointed a Lloyd's surveyor and shortly afterwards came to the United States. He was afterwards transferred to Glasgow and subsequently to Antwerp, and during the ten years spent at these important shipping centers gained a wide experience in mercantile shipbuilding, marine engineering, steel making and ship repairing.

After a most successful career in Antwerp, Mr. McClelland was transferred to Lloyd's head office in London and was promoted to the chief surveyor's staff. In this capacity he traveled extensively in Europe and was entrusted by Lloyd's to carry out various important negotiations. In 1912 he was appointed to Lloyd's New York office and empowered to deal with the plans of vessels submitted for Lloyd's classification by shipbuilders and shipowners in the United States. In his position as principal surveyor Mr. McClelland also co-operated with Mr. James Mancor, Lloyd's principal surveyor for the United States and Canada, in supervising the general surveying duties in this country. He is, therefore, accustomed to dealing with both the technical and practical aspect of questions relating to new construction and ship repair, having an intimate and detailed knowledge of shipbuilding methods and practice in the United States and being familiar with the various shipbuilding and steel making plants in this country.

Mr. McClelland is a man of strong personality and the American Bureau of Shipping is to be congratulated upon having secured as its chief surveyor one whose appointment has received the uniform approbation of the various shipping interests in this country.

A further valuable addition to the technical staff of the American Bureau is the appointment of Mr. James W. Lee, formerly of Baltimore, Md., well known as a naval architect with long experience in the United States Navy Department and the Revenue Cutter Service, as well as the manager of a large shipbuilding plant in Baltimore. Mr. Lee took charge of the office of the Bureau at Newport News, Va., on April 15 and will cover also the Norfolk district.

Another appointment recently made is that of Mr. Joseph E. Borden as head of the Philadelphia office of the Bureau. Mr. Borden's appointment became effective on May 1.

Other appointments are under consideration and will be determined as rapidly as possible. Meanwhile the vitally important work of revising the Bureau's Classification Rules and Regulations will be undertaken, so that they will represent the most advanced requirements for modern safe ship construction.

Utility of Exhaust Steam in a Shipyard

Speaking in a general way, it can fairly be said that the power generating methods of industrial plants have relatively stood still while central station and marine practice has been forging ahead. By means of the steam turbine, the high vacuum condenser, improved boiler room practice and similar expedients, fuel costs in large power stations have been reduced to a minimum. Large numbers of industrial plants have, on the other hand, been loath to discard machinery as yet unimpaired and are still operating reciprocating engines of only moderate steam economy, non-condensing or with low vacua. However, by introducing a low-pressure turbine, many of these plants could greatly reduce fuel bills while retaining to good advantage their present equipment.

As an example, the shipyard of the Newport News Shipbuilding & Dry Dock Company, of Newport News, Va., was formerly supplied with electric power by three McIntosh & Seymour engine-driven generating sets of 600 kilowatts each, one of which was operated continuously for carrying the yard load, while the other two were used only when pumping out dry docks. The demand for power increasing, it was found upon investigation that sufficient exhaust steam could be obtained from the four air compressors and four hydraulic pumps in use in the yard to operate a 1400-kilowatt low-pressure turbine. This would be more than sufficient for carrying the yard load, while the reciprocating units could be retained as spares, to be used only when pumping out dry docks.

Because of its much greater simplicity, less cost for the complete equipment and high overall efficiency, a gear-driven direct current generator was selected and installed. This unit consists of a DeLaval low-pressure turbine, operating at 3,000 revolutions per minute, driving two 700 kilowatt Crocker-Wheeler direct-current dynamos at 500 revolutions per minute. The turbine is of the pressure stage type and receives the exhaust from air compressors and hydraulic pumps at a pressure of about 1 pound gage, exhausting to a surface condenser having 7,015 square feet of cooling surface and served by a rotative dry vacuum pump and a two-stage, turbine-driven hot well pump. A second surface condenser in the same power house can be connected up if necessary to take care of unusual loads.

The double generator arrangement results in an exceptionally neat arrangement for a unit of this capacity, as the pressures on the bearings and gear teeth are greatly reduced as compared with a single gear transmitting the same power, while the generators admit of series and parallel connection for two different voltages. It is also possible to operate one generator alone in case of accident to the other.

The normal yard load of about 1000 kilowatts at 220 volts is regularly carried by the turbine-driven generators, while when pumping out a dry dock the combined load of aproximately 2,300 kilowatts is carried by connecting one of the 600-kilowatt engine-driven generators in series, or, as a booster to the turbo-generators, thus supplying approximately 500 volts for the two large pump motors in the dock pump house. By varying the field of the engine-driven generator, which can be done by the attendant at the dock pump house, the pump load can be controlled. A small centrifugal pump, connected to the regular 220-volt circuit of the yard, is also installed for draining the dock.

While records of steam consumption are not available, the fact that an increased electrical load is now being carried by utilizing exhaust steam formerly wasted from air compressors and pumps indicates a large economy in fuel costs.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Laurenti Submarines

Referring to the statements regarding the Laurenti type of submarines made by Mr. Simon Lake, in his article on "Modern Submarines in War and Peace," on page 400 of the September (1915) issue of INTERNATIONAL MARINE ENGINEERING, the writer wishes to state that Mr. Lake proposed his type of submarine to the Italian navy in the year 1905. Minister Mirabello submitted the matter to a committee, and the members of the committee conferred with Mr. Lake, with the consequence that submarines of the Lake type were not purchased for the Italian navy.

The writer also takes exception to the statement which Mr. Lake attributes to Minister Mirabello and the committee regarding the deficiency of longitudinal stability in submarines of the Laurenti type. As a matter of fact, I believe I am correct in stating that Mr. Lake was in Rome in the summer of 1905, while the first submersible of my type, namely the *Glauco,* began her trials in a submerged condition on January of the year 1906, without, however, developing any deficiency in longitudinal stability to which Mr. Lake refers.

Submarines of my type are quite different from the Lake submarines, and hydroplanes of the Lake type have never been adopted on them. C. LAURENTI.

Spezia, Italy.

Economical Method of Removing Ice from the Deck and Rigging of a Vessel

Vessels navigating in the colder latitudes are often inconvenienced by being covered with ice and snow. For the proper working of the ship it is essential that this ice and snow be removed, particularly so in the case of vessels which remain permanently in this latitude, for too great an accumulation of ice might render the boat unstable, especially so in the case of small fishing vessels.

The task of removing ice from decks, rails, rigging, etc., is by no means an easy one. Some of the steam fishing vessels use a small hose with hot water, which is supplied by an injector, and the hot water cuts off the ice. This method is very effective and removes the ice and snow quickly and thoroughly, but it takes considerable hot water, and, of course, is an expensive way of doing it, for the steam must be furnished, in addition to that ordinarily used, causing an increase in coal bills. For the want of a better method it does very well.

The Coast Guard cutter *Seneca* encounters severe trouble from the accumulation of ice and snow on board when she goes on the ice patrol off Newfoundland, and the chief engineer has devised a very simple scheme whereby they can supply plenty of hot water without throwing away available heat units. This method can only be used when the ship is under way, which is generally the case at sea.

The circulating water discharge pipe has been tapped to receive a fairly large connection which leads to the deck service pump. This pump delivers a sufficient portion of the discharged circulating water through the mains to the deck hose, where it can be used in removing the ice. As the circulating water is discharged at a fairly high temperature, it furnishes plenty of heat to loosen the ice, and since this heat would ordinarily be thrown away, the hot water is furnished at no loss in economy. N.

New York.

The Drafting Room

The article on "The Drafting Room," by Chief Draftsman Robinson, in the January issue, was easily worth an entire year's subscription to the magazine to me, as it set forth exactly the principle for which I have always contended and tried to live up to during my twelve years as chief hull draftsman for the ———— Shipbuilding Company. For six years of this period I was naval architect, chief draftsman and checker combined (my work including ship calculations, steel orders and estimates on new work), with a short-handed and underpaid staff, and, in order to turn out the class of work I believed in, and, as advocated by Mr. Robinson, without proper assistants, I was obliged to work ten and a half hours per day four or five out of the six.

My work received considerable praise from the men who had to use the plans, especially in view of the general condition of this yard, but scarcely ever from the management, and then only from a few who could appreciate it.

At the time when the yard and staff were best organized and doing their best work we were badly handicapped in the office through lack of room, there being only one room available for the use of both the engineering and hull staff, an arrangement not conducive to efficiency in either. I and my leading man, who, by the way, was a first-class draftsman, had our quarters in a small attic apartment which had been fitted up for our use, the best accommodation our managers could provide under existing circumstances, and which was facetiously dubbed the "cock loft" by one of our Clyde men. This was reached by a small scuttle and companion ladder, to give it the proper "seafaring touch," and, as the latter was fully up to the requirements as regards steepness, the casualties among the men from falling down or butting their heads against the scuttle cover were rather high. We were the "goats," all right, and developed the characteristics from environment, as nobody but a billygoat could have withstood the range of temperature in this department—from 52 degrees in winter to 105 degrees in the good old summer time.

Finally there came a change in the management, and as it was on this subject of detail on the plans, in particular, on which we disagreed, I was obliged to quit their employ.

Subsequent observation and experience in this case, and in general, in view of the loss of time and money due to inaccurate and half-finished plans, have only strengthened my conviction that such articles as that by Mr. Robinson should tend to educate those in control of shipyards on this point, and indicate to them the probable source of some of the losses of which they so frequently complain.

P. W. K.

Analyzing a Marine Steam Plant*

The object of plant analysis is economy. Having outlined in the last issue the general methods used in making an economic analysis of a steam plant, the details will be taken up consecutively, with a view to looking into those broader economies, which show up on the books under reliability and well-kept schedules and safety, as well as the purely technical or thermal economies which are so dear to the student.

The first possibility of economy is in the purchase of fuel, the source of power. There are two phases of this branch of management: First, to obtain the greatest number of British thermal units per dollar expended; second, to find a coal suitable for the furnaces. An anthracite may have twice the calorific value of a certain bituminous coal, but it may cost more than twice as much. On the other hand, the bituminous coal may have so much clinker, or be so fine that it all goes through the grate bars, or it may take so long to clean fires that the ship cannot make schedule. These items will be taken up in detail.

All fuels are quite closely related. The coal of to-day was wood and plant life many ages ago, and the belief is quite general that the oil of to-day came from the fats and organic structure of a prolific animal and shellfish age. The writer does not pretend to pass upon these theories, but believes that they are quite generally accepted. Geologists have drawn up a table showing the various stages by which wood became coal, and all of these stages exist in the world to-day, and the processes are going on now, as follows:

Material	Carbon Percent	Hydrogen Percent	Oxygen Percent	Total Percent
Wood	49.10	6.30	44.60	100.00
In the course of ages the wood lost a certain percent, as follows	18.65	3.25	24.40	46.30
And became Lignite coal	30.45	3.05	20.20	53.70
This also lost weight	12.35	1.85	18.13	32.23
And became Bituminous coal	18.10	1.20	2.07	21.37
This lost	3.57	0.93	1.32	5.82
And became Anthracite coal	14.53	0.27	0.65	15.45
This lost	1.42	0.14	0.65	2.21
And became Graphite	13.11	0.13	0.00	13.24

In practice all conceivable intermediate grades exist; also, there is such an excellent market for pure graphite that it is made artificially, by electrolytic means. Bearing in mind the relation between the fuels as shown, we find their average calorific values as follows:

Wood, 6,000 B. T. U. for soft wood to 10,000 B. T. U. per pound.

Lignite, about 10,800 B. T. U. per pound.

Bituminous coal, 12,000 B. T. U. per pound.

Anthracite, about 14,000 B. T. U. per pound.

Pure carbon, 14,500 B. T. U. per pound.

In practice, moisture, ash, foreign matter, sulphur, or a surplus of fine dust will greatly reduce the theoretical calorific value of the coal, and an analysis should always be accompanied with a statement as to whether a correction has been made for these impurities, and on what basis.

The complete analysis of coal, together with a bomb test for calorific value, is very valuable in making annual contracts for fuel, but comparatively few engineers know how to use one, or to draw conclusions from the results obtained. The first duty is to obtain a sample of each of the proposed coals, as follows:

Set aside a little pile of about 100 pounds of the coal in question; mix it thoroughly by shoveling to the center; quarter the pile; take one quarter and repeat the process until a five-pound sample representative of the coal is secured. If the coal have large lumps, it is necessary first to break them up fine. A good chemist will prefer to take his own samples, if arrangements can be made.

If coal consists of lumps of one size only, it will take more room per ton than any other kind. The coal that takes the least room per ton is the kind that has all sizes —even fine dust. This principle is used in building pavements, so as to get them dense and hard; and if an engineer wants to get the maximum storage of coal, let him choose that which has all sizes, like run of the mine, provided it has no slate. About one-third more coal can be stored by this method. A ton of anthracite, egg size, will require about 33 cubic feet, and with all sizes about 25 cubic feet. The softer coals run all the way up to 40 cubic feet per ton, even for mixed sizes, according to the hardness and specific gravity. These facts are mentioned because these characteristics should be observed and measured with sieves, when sampling, as follows:

A hundred pounds average sample is taken and put through six sieves, 3-inch, 2-inch, 1-inch, ½-inch, ¼-inch and 1/16-inch. The amount left on each sieve is weighed; the sample is then crushed, quartered, etc., as described. The seive test may represent two extremes, one having so much fine stuff that it will all go through the bars, the other being all lumps that are easy to burn but take a third more space to store.

The next test is the specific gravity, which will be taken and furnished by the chemist. This is the number of times that the lumps of coal are heavier than water, and indicate the hardness and age of the coal. The specific gravity varies from 0.6 for wood and fuels that will float up to 2.2 for hard coal, anthracite and graphitic anthracite. The specific gravity is almost an exact index of the age and softness of a coal. It must be remembered that this is not passed on as a scientific fact, but merely as an empirical index for a practical engineer.

The next test is for moisture. The moisture in coal varies from nothing up to 20 percent and is to be reckoned as an absolute loss; for instance, 10 percent moisture in a pound of coal means (by reference to steam tables) that about 110 B. T. U. are lost from every pound of coal in turning the water to steam. If the coal has a calorific value of 11,000 B. T. U., the loss would be 1 percent. This is not a large amount but is one of the items which add to large total losses.

The next test is for volatile matter, known as hydrocarbons, tarry matter, etc., as distinguished from the pure or "fixed" carbon. This test has several objects, the most important being to determine the general character of the coal and its probable action on the furnace. A coal running more than 90 percent free carbon would be classed as an anthracite. It would be easy to fire and would have about 14,500 B. T. U. calorific value. A coal running 80 percent free carbon would have 15,840 B. T. U., because of the high calorific value of the volatile hydrocarbons which approach oil in calorific value. This type is the most economical and valuable of all steam coals and ranks as a rather soft anthracite or hard bituminous coal. A coal running 50 percent free carbon would have only about 12,240 B. T. U., because, while it has more volatile hydrocarbons, they are so much lighter than the pure carbon that the total drops in value. Such a coal would be hard to fire, and would cake, requiring much work with the bars, besides being very smoky, because a Scotch boiler is a poor furnace in which to burn such coal, as will be explained in detail later.

The test for ash is one of the most important, because

* The first letter on this subject appeared in the April issue.

it takes heat to fuse ash, besides making firing very hard, since ash is clinker, and if the ash have any iron or iron and sulphur (pyrites) the ash will weld on to the grate bars and be very hard to remove; so the ash itself should be analyzed as well as the coal. Coal can contain any amount of ash, according as to how it is mined and separated from the surrounding non-combustible material, but good steam coal should not contain more than 6 percent of ash, and the loss due to ash may be reckoned as approximately equal to the percentage of ash.

The test for sulphur is also very important, because sulphur is a harmful ingredient. By itself it has a calorific value of about 6,000 B. T. U., and in the form of pyrites, in which it usually occurs in coal, about half this value, but this calorific value is negligible compared to the harm done. The sulphur dioxide formed in the process of combustion combines with the moisture formed from the combustion of the hydrocarbons, or the moisture normal to the coal, and generates sulphuric acid vapor, which attacks the iron work of the stack, the boilers and uptakes. Also, the pyrites have a dangerous habit of oxidizing under the action of the air, particularly if in a warm place, until enough heat is generated to cause spontaneous combustion in the bunkers or other storage. It is very bad to admit steam in such cases, because the steam combines with the sulphur dioxide to form sulphuric acid, which reacts on additional steam to generate more heat, and accounts for the fact that bunker fires seem to increase, rather than decrease, under the action of steam.

After receiving the analysis of various coals, they should be compared item by item; the various losses calculated and set against them; after which even a fairly high-priced coal may be found to represent more calorific value and less trouble per dollar than any of the others. Samples of coal put aboard ship should also be taken, and the analyses checked against complaints made by the chief engineer.

A Scotch boiler has the poorest kind of a furnace for getting results from a coal. A hard coal can be burned in such a furnace with fair economy, but a soft coal needs so much flame room and such high temperatures that the volatile parts will condense as soot in the boiler tubes without burning. It does no good to admit air near the bridge wall, because the hydrocarbons will not burn unless incandescent. The ideal conditions would be a fairly large combustion chamber, surrounded with incandescent brick work; air admitted above the fire bed, for the purpose of burning the distilled vapors from the green coal. These vapors are very high in calorific value unless ignited by hot brick work or hot fire bed, and not even then unless supplied with air. These conditions cannot be realized with a Scotch boiler, but they can be approximated by the use of a little brick work judiciously placed, large combustion chambers, air shutters in the doors, methods of firing and a proper cognizance of new types of boilers and combustion methods which tend to better these conditions.

It is certain that nothing adds to the reliability and fuel economy of a marine plant like the selection and use of the fuel, and these letters on the analysis of steam plants aim to begin at the source of the power for analysis and economy. The next letter will analyze the use of coal and the science of firing, with a view to effecting not only an economy of coal, but to increase the efficiency of the fireman with a view to his advancement. These remarks will not be entirely theory, as the writer has served time on the business end of a coal scoop.

E. N. Percy.

Feed Pumps and Methods Used to Overhaul Them

Feed pumps as built and installed are usually a little light in some parts and consequently various methods are being brought to light in handling them. On some ships where feed pumps are located so that the suction is not lower than the bottom of the feed tank there is danger

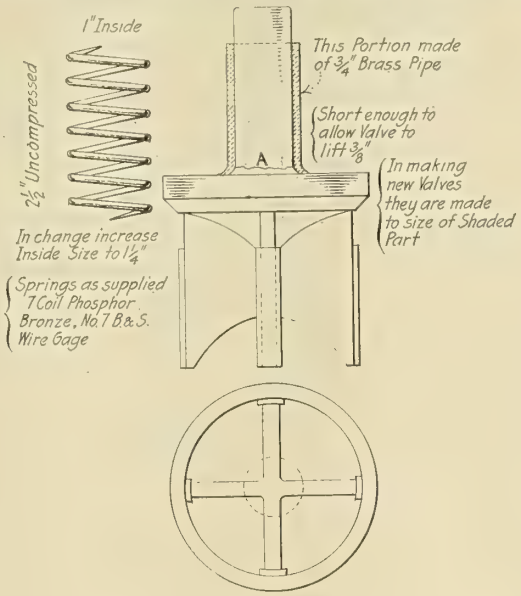

1" Inside
2½" Uncompressed
This Portion made of ¾" Brass Pipe
Short enough to allow Valve to lift ⅜"
A
In making new Valves they are made to Size of Shaded Part
In change increase Inside Size to 1¼"
Springs as supplied 7 Coil Phosphor Bronze, No. 7 B. & S. Wire Gage

Fig. 1

of the pumps losing a suction when the water is low or the pumps hot, as will be the case at some time or other.

When a pump loses its suction there is danger of breakage of valve stems, as has been found by experience. Some time ago the writer noticed that nearly all such

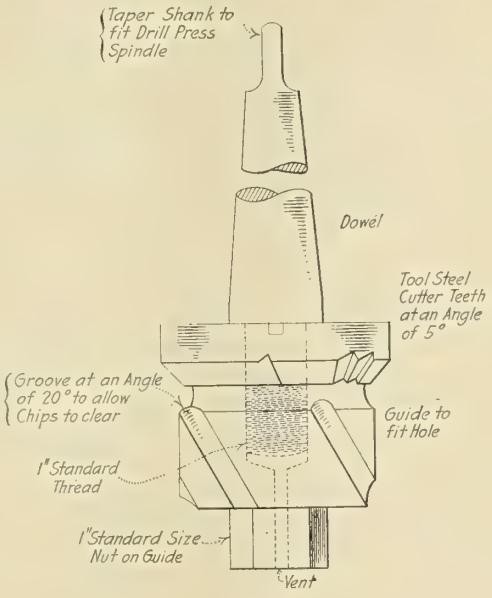

Taper Shank to fit Drill Press Spindle
Dowel
Tool Steel Cutter Teeth at an Angle of 5°
Groove at an Angle of 20° to allow Chips to clear
Guide to fit Hole
1" Standard Thread
1" Standard Size Nut on Guide
Vent

Fig. 2

"breaks" were found at the point marked *A* on Fig. 1. This was overcome by reaming a piece of ¾-inch brass pipe with a ⅞-inch reamer and chamfering the bottom end as shown in Fig. 1, and thus reinforcing the valves that were put in to remove the broken ones. The springs were found to have been spread so that they would pass over the pipe, being nearly 1⅛ inches diameter. This pipe was cut short enough to allow the valve to lift at

least 3/8 inch. This remedy was found to be very effective, but as new valves were cast they were left just that much heavier, as shown by Fig. 1.

When new valves were received on board in the rough they were machined as follows: The first operation was to chuck them in a four-jaw chuck, being careful to true up well and turning them to size, as shown by Fig. 1. They were then taken and machined to size on the other end by holding them in a special spring collett, and when they needed refacing they were easily trued up, as all that was required was to put them in the same collett. This method cut down the time required to overhaul any pump of this make.

Of course, as the stem did not break very frequently, there were some other things that needed attention, and it was found that the wear on seats was such that they had to be reseated as often as the pump was stripped for overhaul. As this was a long job when done in the old way by chucking the seat clusters in a lathe for each seat, to overcome this a special cutter was made as shown by Figs. 2, 3 and 4. Fig. 2 shows a general view while Figs. 3 and 4 show more detailed views of the cutter and guide.

The shank was machined of a piece of mild steel on centers. The first operation was to machine to fit the drill press spindle, then machining the shoulder and the lower end, making it a standard 1-inch body bound fit, and cutting a standard 1-inch thread; then it was taken out and a dowel placed in position, as shown. Next a piece of tool steel was taken and machine-faced on one side and a hole bored to fit the shank. We then put on an arbor and faced the other side. A slot was machined to receive the dowel. It was then put on the shank and machined to size and angle. The teeth were milled, being cut at an angle of 5 degrees and undercut so that they could be easily reground. The reason that the teeth were cut at an angle was so that the cutter would sort of drag and not have a tendency to pull itself into the work. The piece was then tempered.

The last operation consisted of machining the guide. This was done by taking a piece of mild steel, facing one end and drilling and tapping to 1 inch. This was then screwed on the shank when the cutter was in place, and as the centering hole was used to hold the center cutter in line, it was then turned to proper size to act as a guide. After this operation the nut part was milled and the grooves were milled out at an angle of 20 degrees, so that the chips would all pass out and not clog the cutter.

Fig. 5 shows the cutter in position for use and, as will be seen, it was necessary to have a special bolt and two washers to hold the seat cluster in its proper position. Also one sleeve was needed when reseating discharge seats, as the hole in them is slightly larger than the hole in the suction clusters. Once having the cutter shank in place and clusters at hand, it is only necessary to bolt a cluster in place, as shown, and then all that is needed when one seat is finished is to revolve the press table the required distance, which is one-fifth of a revolution. It was found that they could be reseated much quicker and much evener, as the press spindle stop can be brought into play, so that all seats will be same depth when finished.

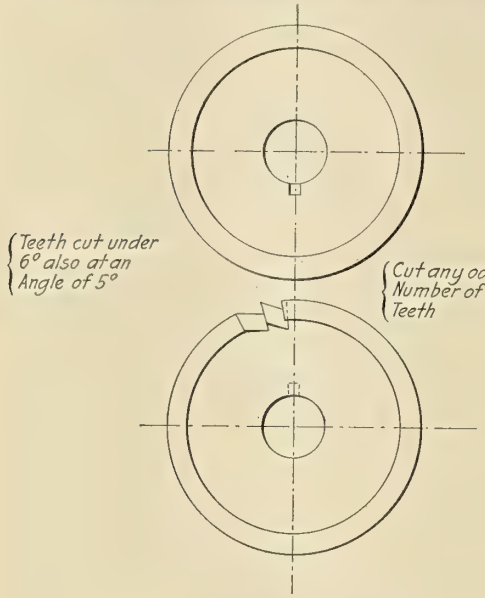


Fig. 3

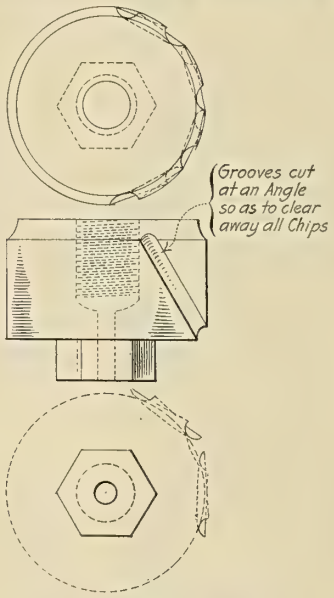


Fig. 4.—Details of Guide

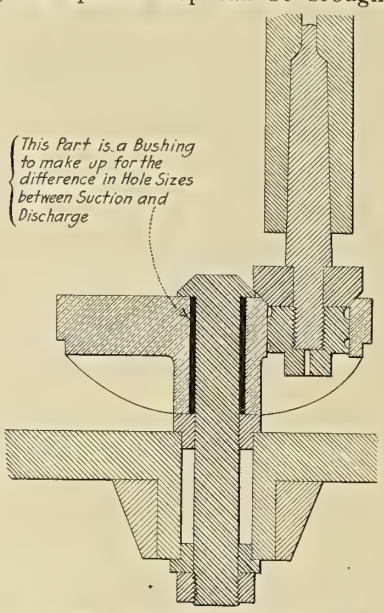


Fig. 5.—Reseating Cutter in Position on Radial Drill Press

The tool just described is considered to be one of the handiest tools that we have on the ship, as we find with this it becomes a very easy matter to reseat the valves, whereas formerly that part of the work was always thought to be the most tedious of the whole lot. While the sketches which illustrate this letter are somewhat crude, as the writer did not have the time to prepare finished drawings, nevertheless they are offered with the hope that others may see where they are losing a lot of time in overhauling the same make of feed pumps. As this letter refers only to the overhauling of the water end of the pumps, a later letter will take up the matter of overhauling the steam end of feed pumps.

F. C. Wolf,
Machinist, U. S. N.

Cadetships in the United States Coast Guard.—A fine opportunity for young men to obtain life positions in the Government is presented by examinations which will be held on June 26 at Washington, D. C., and at several other large cities in different sections of the country to fill about ten vacancies in the line and engineer corps at the Coast Guard Academy, New London, Conn. The course at the Academy covers a period of three years for line cadets and one year for cadet engineers. Information regarding the requirements for candidates for these examinations and the pay received by the cadets and by the commissioned officers after graduation can be obtained from the Captain-Commandant, U. S. Coast Guard, Treasury Department, Washington, D. C.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Steam Consumption of Direct Acting Simplex Feed Pump

Q.—Will you tell me about how much steam an ordinary direct-acting simplex feed pump uses? S. P.

A.—A pump of the type mentioned, working under service conditions and in a normal state of maintenance, gave the following results when tested in the laboratory. It is easy to see from this why pumps of this sort are classed as "steam-eaters" aboard ship:

TEST OF STEAM PUMP, 7-INCH BY 4-INCH BY 10-INCH STROKE, DISCHARGING AGAINST A BOILER PRESSURE OF 190 POUNDS GAGE

Throttle Pressure Abs.	Piston Speed Ft. Per Min.	Steam Per I. H. P. Hr.	Water Pumped (Lbs.) Per Lb. Steam
72	37.8	144	32.4
81	57.0	133	34.0
88	67.2	111	39.0
88	81.6	72	60.3
91	98.0	67	73.0

Hatchet Planimeter

Q.—What is the so-called "hatchet planimeter"? I have heard it mentioned as being a planimeter that could be made by a fellow without elaborate tools, and am interested to know if that is so, and if so, how to make it? DRAFTSMAN.

A.—The hatchet planimeter consists of a single rod of metal bent into the form of a shallow inverted U. One end is sharpened to a point and the other has a sharp edge like a knife edge, whose plane passes through the tracing point. It is used by starting the tracing point as near the center of gravity of the area to be measured as can be estimated, then over the straight line to the boundary, and thence around the boundary in a right-handed direction and back along the original line to the starting point. The distance between the initial and final positions of the knife edge multiplied by the length of the arm from the point of contact of the knife edge to the tracing point (all in inches) gives the area in square inches. It is not accurate and needs to be kept vertical at all times. Its inaccuracies are minimized by going over the area a second time in the reverse direction, and averaging the two results.

Rule for Expansion of Steam

Q.—(1) What is the approximate rule for the expansion of steam; that is, if you knew the initial pressure and the point of cutoff, how can you estimate the pressure at the end of the stroke?

(2) How would you estimate by the same rule the pressure at the part of the stroke after cutoff has occurred? J. K.

A.—There is no expression which accurately represents the action of steam expanding in the cylinder of a steam engine. A common expression and the easiest to work with mathematically, is $P \times V = P_1 \times V_1$, and probably this will be sufficiently close for your purpose:

P = pressure, absolute pounds per square inch at cutoff.
V = volume in cubic feet at cutoff, including clearance.
P_1 = pressure desired at V_1.
V_1 = cylinder volume in cubic feet to point desired + clearance volume.

An investigation recently carried out by Clayton * to determine the relationship between the expansion line and the quality of steam at cutoff indicates that the expansion line may be represented in the case of non-jacketed engines by the expression $P \times V^n = P_1 \times V_1^n$, where n varies from 0.8 to 1.2, depending upon the type of engine, the location of cutoff, initial pressure, etc. The following, taken from a small triple expansion marine engine in the laboratory, may be of interest and will show how wide the variations are in practice in different ends of the same cylinders when the engine is operating under uniform conditions:

	Cut-off	n
High Pressure Cylinder—		
Crank end	.58	.89
Head end	.65	.92
Intermediate Cylinder—		
Crank end	.67	.82
Head end	.69	1.0

$I.H.P. = 40$ $R.P.M. = 180$

Engine $= \dfrac{6\frac{1}{2}'' \times 9\frac{3}{4}'' \times 16''}{10''}$, boiler pressure = 120 lbs. gage.

The method of using the first expression suggested is best shown by an example. Let us suppose the cylinder clearance is 10 percent, cutoff = ½ stroke, and pressure at cutoff is 100 pounds above the atmospheric line. It is desired to predict approximately the pressure at ¾ stroke and at 0.8 stroke. The strokes are directly proportioned to the volume displaced by the piston plus the clearance; so that if we let D = the entire piston displacement it drops out of the expression, and we can deal with strokes instead as follows:

$$P V = P_1 V_1 \quad P_1 = P \frac{V}{V_1} = (100 + 14.7) \frac{\frac{1}{2} D + .1 D}{\frac{3}{4} D + .1 D}$$

$$= (114.7) \frac{.6}{.85} = 80.9$$

pounds absolute for the pressure at ¾ stroke, and

$$(114.7) \frac{.6}{.9} = .764$$

pounds absolute for the pressure at .8 stroke.

Michell and Kingsbury Thrust Bearings

Q.—Kindly give some information, with diagrams, in MARINE ENGINEERING, regarding the Michell thrust bearing? V. C.

A.—The evolution of the high pressure thrust bearing of the Michell and Kingsbury types extends back over a long period of time and is intimately associated with the theoretical and experimental investigation of lubrication. Much experimental work was done from 1873 to 1903, and as far back as 1884 Lord Rayleigh presented a complete mathematical treatment of the general theory. A few years later (1886) Professor Osborne Reynolds tied in the general analytical treatment with the experimental work of

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

* A New Analysis of Cylinder Performance of Reciprocating Engines, by A. Paul Clayton. University of Illinois Bulletin No. 26.

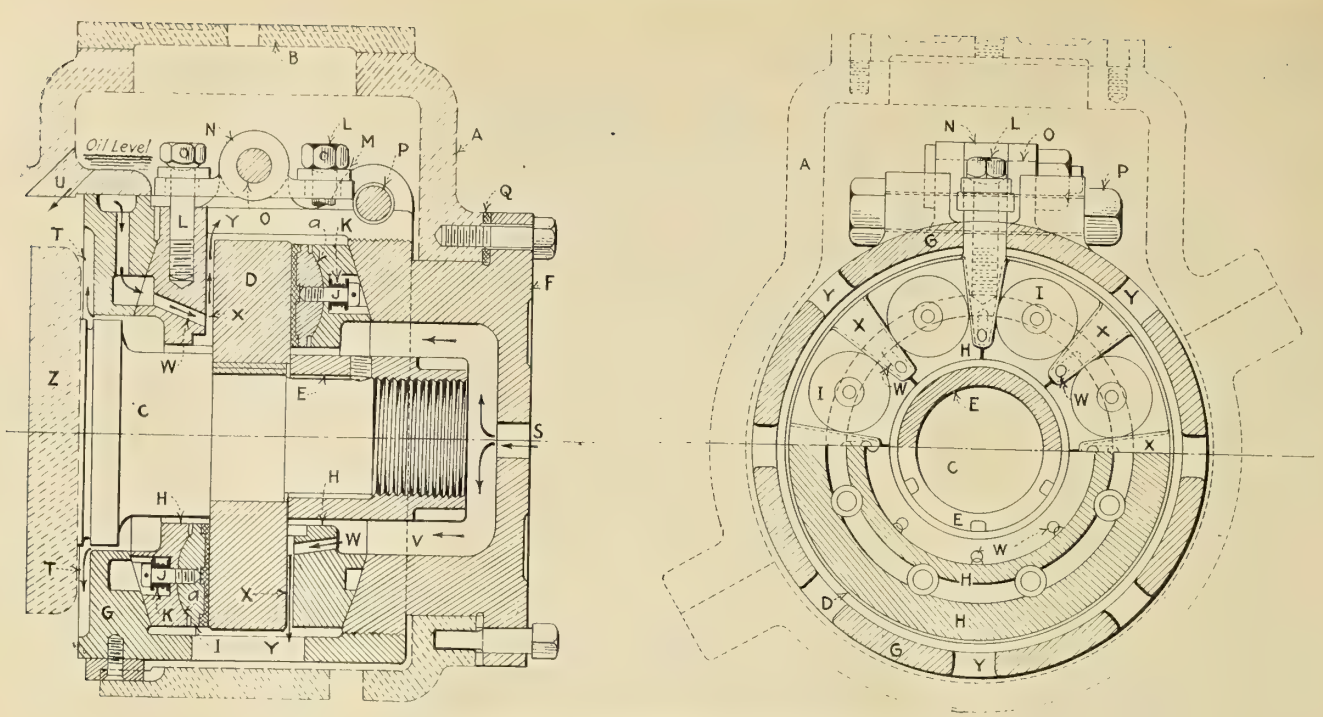


Fig. 1.—Sections of the Kingsbury Thrust Bearing

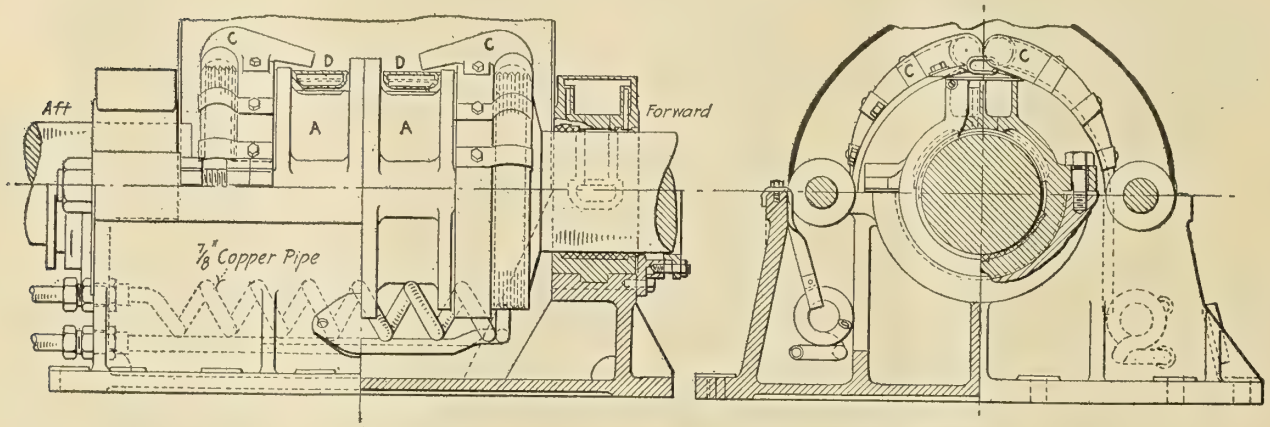


Fig. 2

Fig. 3
Section at Z-Z

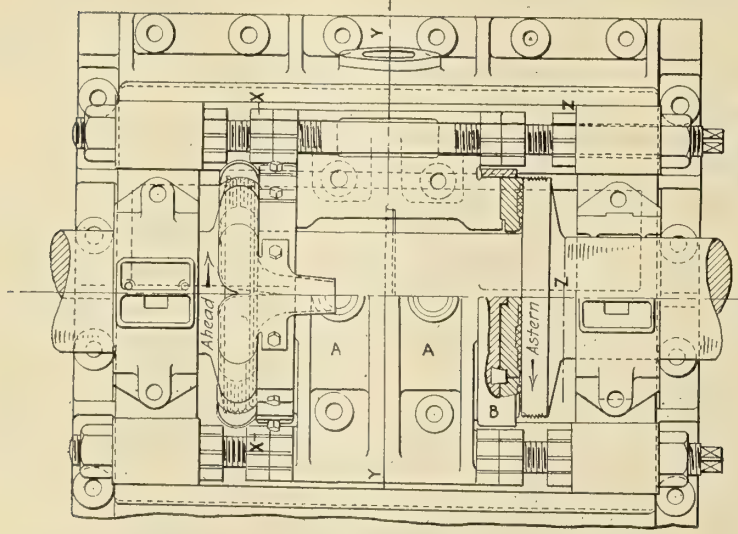


Fig. 4

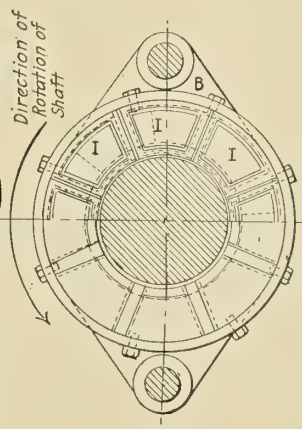


Fig. 5
Section at X-X

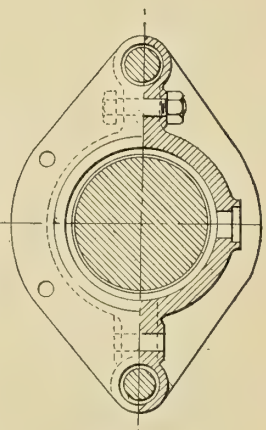


Fig. 6
Section at Y-Y

(Drawing reproduced from *Engineering*)

Details of the Michell Thrust Bearing

Tower, and this seems to have furnished the basis of the development of the Michell bearing.

Michell's patent was issued in 1905, and had been preceded by considerable experimental work carried out by him. In this bearing, the thrust is borne by annular blocks (*I-I-I*, Fig. 5) pivoted at their theoretical centers of pressure, which lie three-fifths the length back from the leading edge. When running, these blocks tilt slightly about this pivot, as in Fig. 8, and the film of oil is drawn into a gradually contracting channel, giving perfect lubrication and permitting extremely high bearing pressures to be carried.

Where about fifty pounds per square inch has been the generally accepted figure for marine work these bearings operate customarily at about 500 pounds per square inch and with an enormous reduction in friction losses.

A further development of this idea was the pivoting of the slippers at their centers, as in the patents gotten out by Ferranti (1910) and Sir Charles Parsons (1912) in Great

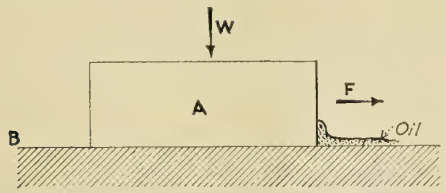


Fig. 7.—Ordinary Collar Bearing. Oil Squeezed Out and Surfaces in Metallic Contact. Coefficient of Friction About 0.03

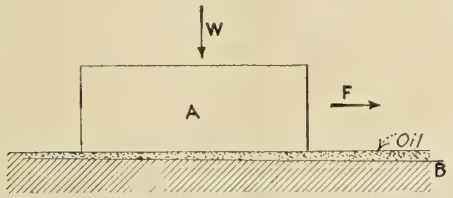


Fig. 8.—Michell Bearing. Wedge of Oil Maintained Between the Surfaces and No Metallic Contact. Coefficient About 0.003

Britain, and Kingsbury (1910) (Fig. 1), in the United States. This seems to work equally well and has the further advantage that the shaft may run in either direction without shifting the point of support. These principles have also been applied to journal bearings by Michell (1911) and Parsons (1912-1913).

Tests were carried out by the Westinghouse Machine Company to determine the maximum pressures which could be carried by a Kingsbury bearing, and the results were astonishing. Starting with a bearing pressure of about 1,000 pounds per square inch, the pressure was increased successively over a series of runs until it reached 7,000 pounds, when the babbitt was squeezed out, but no trouble was experienced from failure of the lubrication, and the conclusion was that the unit pressure was limited by the flowing pressure of the bearing lining. It was further an interesting fact that the babbitt flowed on the leading edge or opposite to the direction of rotation, as well as the other three edges. The coefficient of friction for the Kingsbury thrust bearing has been found by a large number of tests to vary from .0008 to .003, and the value commonly taken for calculation is .002. This corresponds to values for good ball-bearings, though the starting or initial friction is considerably higher. Bearings of this character have been successfully applied to many steamships and turbine installations and have given satisfaction.

Following is a description of the Michell bearing installed in the *S.S. Cuidad de Buenos Aires,* as published in *Engineering* (London), December, 1914:

Details of the construction of the bearing are shown in Figs. 2 to 6. The shaft, which is 9 inches in diameter, rests on ordinary bearings at each end of the thrust-block housing (see Figs. 2 and 3), and has but two collars, of which one is used in forward running and the other when running astern. One of these collars is shown exposed in Fig. 4, the distance between the opposite faces of the two being 20 inches.

A bridge-piece *A*, Figs. 2 and 4, embraces the shaft between the collars, being split in halves, as shown in Fig. 6, so that it can be placed in position. It is provided with lugs to take the 2¼-inch bolts shown in Fig. 4, by which the thrust is finally transmitted to the housing, and is clamped in place by the double nuts shown. Besides being split radially, the bridge-piece is also divided along a plane normal to the axis of the shaft, the components being held together by bolts passing through the 1¼-inch flanges shown. This joint makes possible small adjustments in the total length of the bridge-piece by using in the joint packings of different thicknesses. A set of eight pivoted blocks (see Fig. 5) at each end transmits the thrust from the corresponding collar to the bridge-piece. Keys let into the faces prevent the segmental blocks being carried round by the motion of the opposing collar, while they are held in place radially by half hoops *B* of steel, studded to the bridge-piece, as best seen in Fig. 5. To ensure an ample supply of lubricant, the collars dip into oil confined in the lower part of the housing, and by the serrations shown pick up oil, which they deliver to the guides *C*, which feed the oil-cups, shown in the bridge-piece at *D*. These, by appropriate channels, deliver the oil to the annulus between the shaft and bridge-piece, best seen in Fig. 6. From this annulus the oil makes its way out and back into the housing again, between the faces of the collars and segmental blocks. A light, wrought iron cover protects the block from the dust and dirt of the engine room.

Lubricant for Use in Cutting Threads in Mild Steel Bolts

Q.—Can you give me the constituents of a lubricating compound to be used when cutting screw threads on mild steel bolts? I have used lard oil, but some time ago worked with a made-up compound which worked better and which I was told had no lard oil in it. Machinist.

A.—A good screw-cutting oil can be made by taking three parts of any parrafin base oil of about 29 degrees Baume and mixing with it one part of cottonseed oil.

Viscosity Seales

Q.—Will you please give me the formula for converting viscosity in the Saybolt scale to the Engler scale? L. B.

A.—For values up to 500″ Engler and 160″ Saybolt *A*, 0.32 Engler = Saybolt *A* — 4.6.

For values 500″ to 1,200″ Engler and 160″ to 370″ Saybolt, 0.32 Engler = Saybolt *A* — 6.0.

Overheating of Enclosed Motors

Q.—I have a 3-horsepower, 1,000 revolutions per minute, motor which is now operating under about three-quarter full load. This motor is so situated as to be liable to be wet, and I wish to make some covers to totally enclose it. Will the motor overheat if totally enclosed? E. E.

A.—Probably not; the temperature rise may be about what the motor would have at full load. If the rise exceeds 40 degrees Centigrade or 72 degrees Fahrenheit you better provide ribs on the covers to increase the radiating surface or open the covers slightly.

Marine Articles in the Engineering Press

Lubrication—Descriptions of 14,000-Ton Floating Dry Dock and Torpedo Boat Destroyer—Education of Apprentices

Practical Lubrication.—By Lieutenant G. S. Bryan, U. S. N. A brief explanation of the general information needed to assist an engineer with lubrication problems. The article discusses the effect of temperature, load and speed on bearings. In selecting suitable oils for lubrication three factors must be considered—temperature, pressure and journal running speed. The physical constants which must be understood are viscosity, flash point, fire point, specific gravity, color and cold point. The general qualifications are explained for marine engine oil, forced lubrication oil, motor cylinder oil, steam cylinder oil, ice machine oil, dynamo oil and air compressor cylinder oil and the paper is concluded with a discussion of the value of greases and graphite as lubricants. 4 illustrations. 5,000 words.—*Journal of the American Society of Naval Engineers,* November, 1915.

A *Floating Dock of* 14,000 *Tons Lifting Power at Rotterdam.*—The docking facilities at Rotterdam have recently received an important addition by the installation at that port of a large floating dock of 14,000 tons lifting power which has been built at the order of Wilton Engineering & Slipway Company by the Nederlandsche Scheepsbouw Maatschappij of Amsterdam. The dock is 510 feet long overall and 110 feet extreme width, capable of accommodating a vessel with a draft of 20 feet 6 inches. The dock is of the bolted sectional type and is divided into three sections for self-docking purposes, the sections being so arranged that when disconnected any two of them can lift the third. The pontoon of the end section is divided into sixteen watertight compartments by transverse and longitudinal watertight bulkheads, while the pontoon of the central section is similarly divided into twelve compartments. The necessary transverse strength of the pontoon is provided by strong transverse girders spaced at 10-foot intervals. Between these girders are arranged longitudinal frames which are diagonally braced across the corners. Transverse framing is also adopted for the side wall. The pumps for operating the dock are electrically driven, the current being supplied from the shore. Each section of the dock is self-contained in regard to pumping arrangements on account of the self-docking feature. 6 illustrations. 600 words.—*The Shipbuilder,* January.

Description and Trials of the United States Torpedo Boat Destroyer Cushing.—By Lieutenant Ormond L. Cox, U. S. N. The *Cushing,* built by the Fore River Shipbuilding Corporation, Quincy, Mass., is a twin screw vessel fitted with Curtis turbines with geared cruising turbines and designed for a speed of 29 knots at about 1,050 tons trial displacement with the main engines developing about 16,000 shaft horsepower. The vessel is 300 feet long between perpendiculars 31 feet 1 inch extreme beam and 17 feet 1 inch molded depth with a load draft of 9 feet 5½ inches. The turbines are designed to develop about 8,000 shaft horsepower running at about 550 revolutions per minute. The cruising turbines are designed to develop 450 shaft horsepower each at 2,000 revolutions per minute and are geared down in a ratio of 7.95 to 1. The cruising unit may be used at all speeds ahead below 16 knots and are disconnected for higher speeds ahead and while reversing. The propellers are three-bladed, of manganese bronze cast solid 7 feet 5½ inches diameter and 6 feet 6⅛ inches pitch, with a projected area of 26.797 square feet; a helicoidal area of 29.67 square feet, and a disk area of 43.69 square feet, making the ratio of projected to disk area .1633, of helicoidal to disk area .6791, and of projected to helicoidal area .9032. Steam is supplied at 265 pounds gage by four oil-burning Yarrow boilers arranged in pairs in two separate compartments, operating under the closed fireroom forced draft system. On her standardization trial a speed of 29.68 knots was attained with the propellers turning at 593.84 revolutions per minute and the engines developing 16,384 shaft horsepower. On the four-hour full speed trial the speed was 29.183 knots on a displacement of 1,048 tons and a draft of 9 feet 5 inches. The main turbines developed 15,280 horsepower, turning at 576.06 revolutions per minute. The evaporation of the boilers was 11.31 pounds per hour per square foot of heating surface, 15.61 pounds per hour per shaft horsepower, and 12.46 pounds per hour per pound of oil. The oil consumption was 1.259 pounds per shaft horsepower hour. 1 illustration, 3 plates, 3 tables. 4,700 words.—*Journal of the American Society of Naval Engineers,* November.

Education of Youths Before and During Their Apprenticeship.—By V. A. Mundella, M. A., B. Sc. A careful analysis of the present system of education in a typical engineering and shipbuilding center in England leads to the conclusion that the important problem is that of the continued education of the elementary school boys. Out of 1,200 branches in the engineering trades, only 38 percent are accounted for as attending evening or day classes, and in the shipbuilding trades only 12 percent are accounted for and more than half of these attended single-subject classes only. Though the attendance of those in the evening classes is good, nevertheless a large percentage of students failed to make satisfactory progress. Furthermore, a large proportion—54 percent—of the students in attendance allowed one or more years to elapse after leaving school before taking up any continued education. This position is considered by the author as unsatisfactory, and he points out the necessity for some form of compulsory continued education. The author considers that the real basis of an effective system of continued education is compulsion in some form or other. Compulsory higher education, he holds, is now a perfectly safe investment, but the returns from the investment cannot be expected immediately; they must be looked for in years to come. 9,000 words.—*Transactions of the North East Coast Institution of Engineers and Shipbuilders,* March.

Cast Iron for High Speed Engine Cylinders.—In modern high speed steam and internal combustion engines, cast iron is up to the present the only metal which has given satisfactory working results when used for the construction of certain vital parts, such as pistons, piston rings and cylinders. The two chief properties required of cast iron for these purposes are maximum resistance to wear and the most perfect running properties under the conditions existing in the engine. The mechanical properties, such as tensile and transverse strength, can usually be obtained sufficiently high to withstand the stresses involved in the use of the generally accepted thickness of material. The modern tendency, however, seems to be to cut down the weights of members, and for this reason higher tensile strength irons will be more and more in demand.—*Engineering.*

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

Contracts for New Ships

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the United Fruit Company, Boston, Mass., for three freight ships, each of about 5,000 tons gross register.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract from the Munson Steamship Line, New York, for a 385-foot steamship of 4,600 tons gross register. This is the fourth ship that the Munson Steamship Line has building in Newport News.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from the Clyde Steamship Company, New York, for four steamers of full canal size to be built from plans drawn by Theodore E. Ferris, naval architect, New York. These vessels were previously erroneously reported to have been ordered by the Mallory Line.

The Pittsburg Steamship Company, Cleveland, Ohio, now has under contract six 12,000-ton ore vessels, four of which will be built by the American Shipbuilding Company, Cleveland, Ohio, and two by the Great Lakes Engineering Works, Detroit, Mich.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Luckenbach Steamship Company, New York, for a fifth steamship.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Mexican Petroleum Corporation, New York, to build two oil tank steamships.

It is reported that the Submarine Boat Corporation, New York, has received a contract from the Russian Government to construct 250 submarine boats at a cost of approximately $70,000,000 (£14,300,000). These boats are to be built in Russian shipyards.

The Newport News Shipbuilding & Dry Dock Company has received a contract from the Standard Oil Company, New York, for the construction of two oil tank steamers to cost about $1,000,000 (£205,000) each. Each vessel will have a carrying capacity of 11,000 tons deadweight. They will be the largest vessels of their class ever built in this country. Both will be oil burners.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from Hasler Brothers, Inc., New York, to build a freight steamship.

The American Shipbuilding Company has received a contract from Barber & Co., New York, to build a freight steamship.

The American Shipbuilding Company has received a contract from the British Columbia Sulphite Fibre Company to build a freight steamship.

The Moore & Scott Iron Works, Oakland, Cal., has received a contract from the Huasteca Petroleum Company, New York, for an oil tank steamship of 10,000 tons deadweight carrying capacity.

The New York Shipbuilding Company, Camden, N. J., has received a contract from the Darrow-Mann Company, Boston, Mass., to build two more colliers. Each vessel will be 369 feet long and will have a capacity of 8,500 tons.

The Great Lakes Engineering Works, Detroit, Mich., has received a contract from Gaston, Williams & Wigmore, Inc., New York, for two 5,000-ton vessels to be delivered in May, 1917.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has received a contract from the Luckenbach Company, New York, to build a steel steamship of 11,000 tons deadweight carrying capacity.

The Chester Shipbuilding Company, Chester, Pa., has received contracts for seven ships in addition to the seven contracts already reported.

R. L. Bean, Camden, Me., will build six four-masted schooners.

The American Bridge Company, Pittsburg, Pa., will build four steel barges for Dollut & Williams, New Orleans, La.

The American Bridge Company is also building four hulls for the United States Government.

The Schultze Shipyard Company, South San Francisco, Cal., has received an order from the Angelo Fasce Company, Callao, Peru, for the construction of an 85-foot cargo schooner to be equipped with a 120 brake horsepower oil engine.

Shipyard Projects

Announcement is made of a new $5,000,000 (£1,025,000) shipbuilding plant, known as the Sun Shipbuilding Company, to be located on the Delaware River at Chester, Pa. The new company plans to specialize in the construction of 10,000-ton freighters and oil tankers, and six building ways will be provided, each capable of taking a vessel 700 feet long. Two thousand five hundred men will be employed at the plant and actual building of vessels will be begun within the next month, the first to be completed by August 1. Contracts for two tankers for the Sun Oil Company, and for four more for other interests, are already in hand.

The United States Senate has passed a bill appropriat- $2,065,000 (£423,000) for equipping the Puget Sound, Wash., Navy Yard for building battleships.

It is reported from Portland, Ore., that the Smith & Watson Iron Works and the Columbia Engineering Works will combine to organize a shipbuilding company.

It is reported that the old Crescent shipyard of the Samuel L. Moore & Sons Corporation, at Elizabethport, N. J., is to be overhauled and arrangements made for the building of steamers up to 300 feet in length. Considerable machinery will be purchased a little later.

Marine Terminal Improvements

It is reported from Houston, Tex., that the wharfage facilities of that port are to be increased by the construction of a second municipal dock at an estimated cost of $400,000 (£82,000).

The Vacuum Oil Company, New York, has purchased a large tract of land in Lincoln Park, N. J., and is planning to build piers, warehouses, factories, machine shops, etc.

The Norfolk & Western Railway Company is building two large steamship piers at Lambert's Point, Va., one for outgoing and the other for incoming freight. The new piers will be fully equipped with Otis inclined elevators, manufactured by the Otis Elevator Company, New

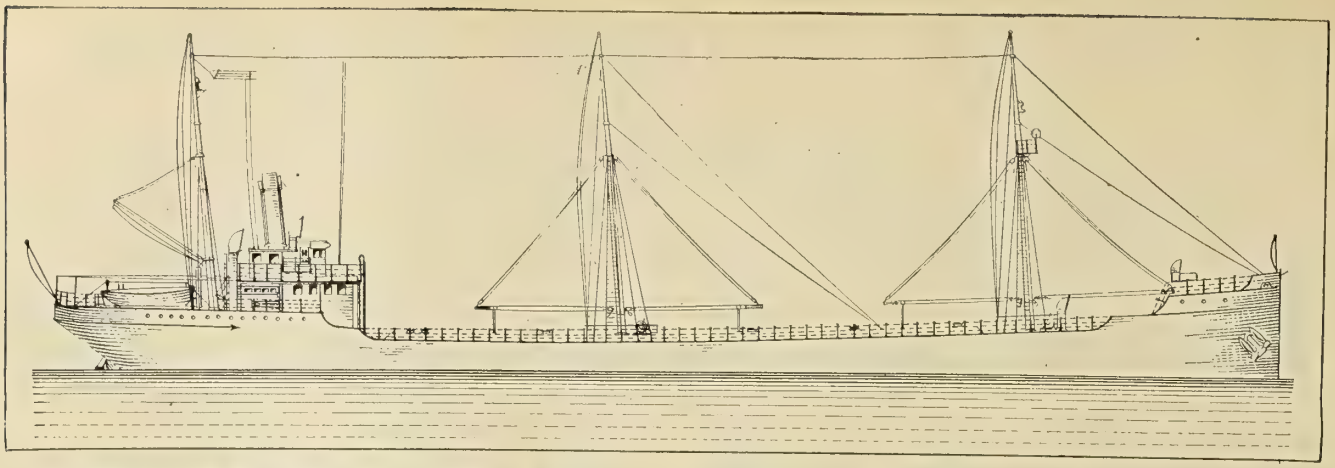


Fig. 1.—Outboard Profile of Motor-Driven Oil Tanker Building for Christoffer Hannevig, Christiania, Norway, by the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., in Accordance with Designs by Cox & Stevens, Naval Architects, New York

York. In all, forty of these elevators will be installed, making the largest installation of this type of freight-handling machinery that has as yet been made at a steamship terminal.

W. H. Stark and the Orange Ice, Light & Water Company, Orange, Tex., are planning to build a 730-foot wharf along the Sabine River front.

The city of Norfolk, Va., is planning to construct docks at a cost of more than $500,000 (£102,500).

The U. S. Engineer Office, Galveston, Tex., accepted bids until April 11 for constructing a wharf at Arkansas Pass, Texas.

Annual Banquet of the American Society of Marine Draftsmen

The annual banquet of the American Society of Marine Draftsmen was held at the Hotel Warwick, Newport News, Va., on Saturday evening, April 22. Arrangements for the banquet were made by a joint committee of the Newport News and Norfolk branches of the society, and representatives of 85 percent of the marine draftsmen of the United States were present at the banquet.

Fast Trip of Steam Yacht Whileaway

The steam yacht *Whileaway*, designed by Messrs. Cox & Stevens, naval architects, New York, and built by the William Cramp & Sons' Ship & Engine Building Company, Philadelphia, Pa., for Mr. Harry Payne Whitney, recently made a record run from Key West to Havana, Cuba, making the trip from light to light in four hours forty-seven minutes, bettering the time of the steamers *Governor Cobb* and *Olivette* on this run. The *Whileaway* is an entirely new type of vessel, and it is thought that she will be a forerunner of many more yachts, as she caters particularly to the requirements of American owners, who for the most part use their vessels during warm weather, and therefore require large and well-ventilated and lighted quarters. A further requirement of the average American yacht owner is that he must be able to move quickly from one port to another and be able to enter all of the harbors along the Atlantic coast, thus making a moderate draft of the vessel essential.

The *Whileaway* is 177 feet long over all, 25 feet beam, 9 feet maximum draft, and has a cruising speed of 16 knots. Propulsion is by twin screws driven by Parsons turbines supplied with steam by oil-burning boilers. When forced, the vessel is capable of a speed in excess of 18½ knots.

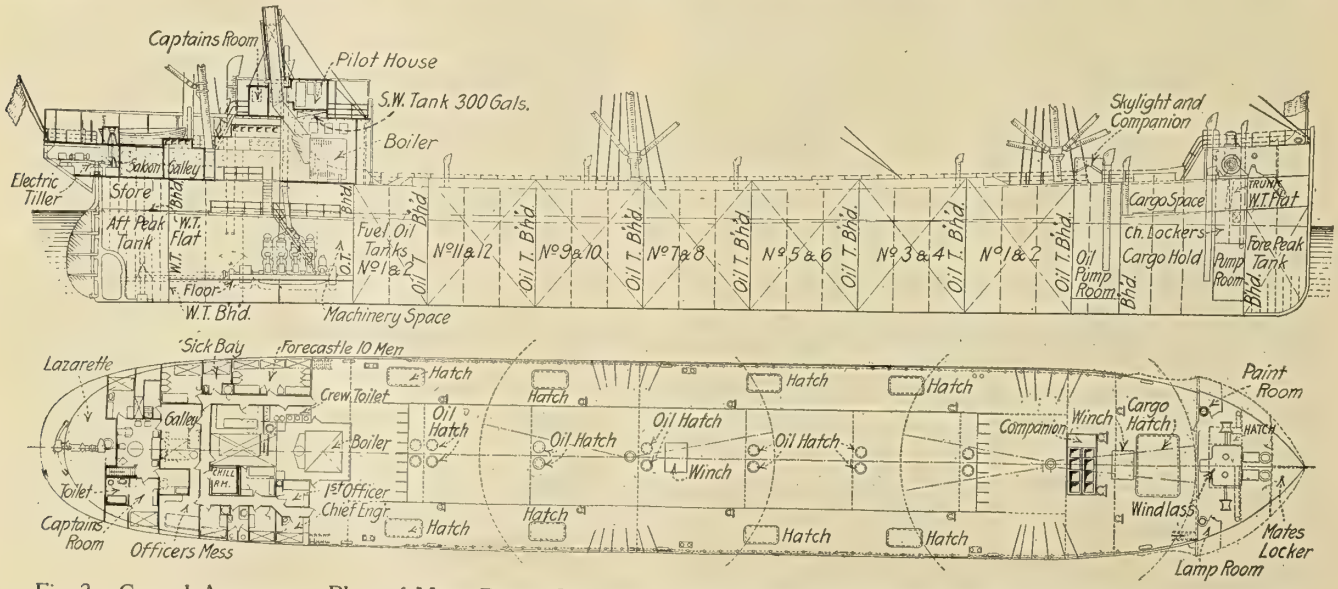
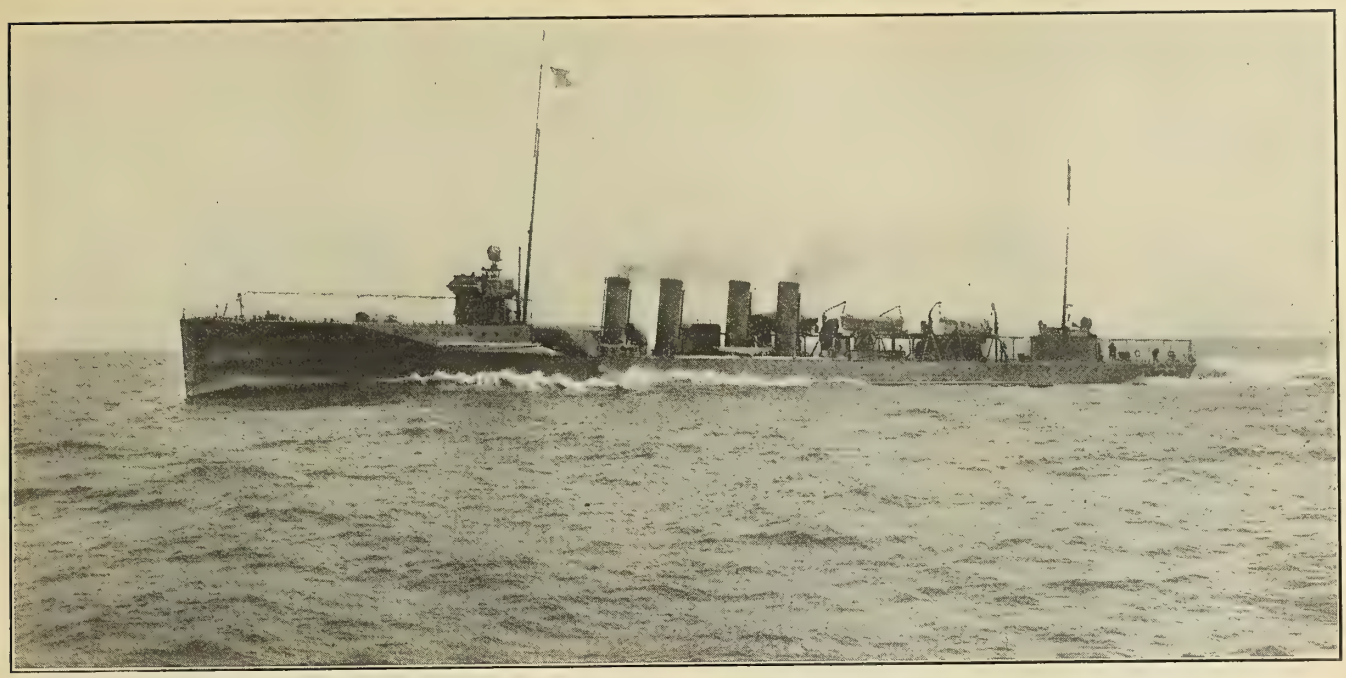
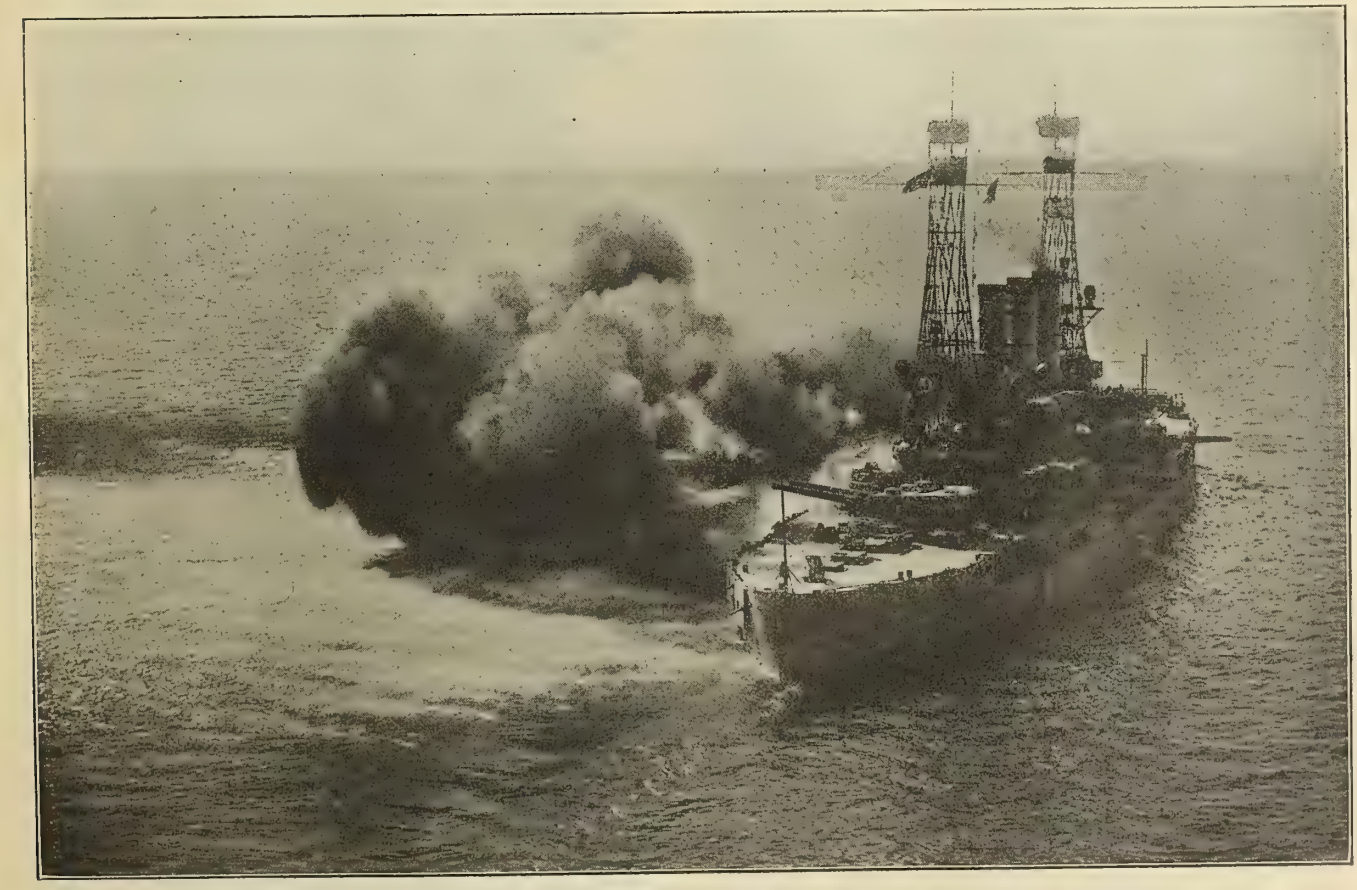


Fig. 2.—General Arrangement Plans of Motor-Driven Oil Tanker 306 Feet Long, 47 Feet Beam and 28 Feet Depth, to be Propelled by Three Screws, Each Driven by a 600-Brake-Horsepower Bolinders Oil Engine. Four of These Vessels Now Building Will Be Followed by Three Others Propelled by Geared Steam Turbines



United States Torpedo-Boat Destroyer *Wainwright*, Just Completed by the New York Shipbuilding Company, Camden, N. J.
Speed on Trial, 31.52 Knots

In type, the *Whileaway* is a development of the large motor cruiser, having all the comforts and roominess of the houseboat, with large windows in place of air ports, a great amount of deck space and unusual head room. At the same time she has excellent qualities as a seagoing boat. The designers of the vessel report that as a result of the successful performance of the *Whileaway* and the remarkable combination of comfort, speed and seaworthiness which she represents, they are now designing several other large steam yachts of the same general type, among these being a 240-foot, 26-knot vessel for Mr. J. N. Willys, which is being built by the Bath Iron Works, Bath, Me.



United States Battleship of the *New Hampshire* Class Firing a Broadside in Practice Maneuvers

ENGINEERING SPECIALTIES

Correction

In the description of a 24-foot motor lifeboat published on page 220 of our April issue, it was erroneously stated that the lifeboat described was built by the Welin Marine Equipment Company, Long Island City, N. Y. The manufacturers of this type of lifeboat are the Gas Engine & Power Company and Chas L. Seabury & Co., Consolidated, Morris Heights, New York.

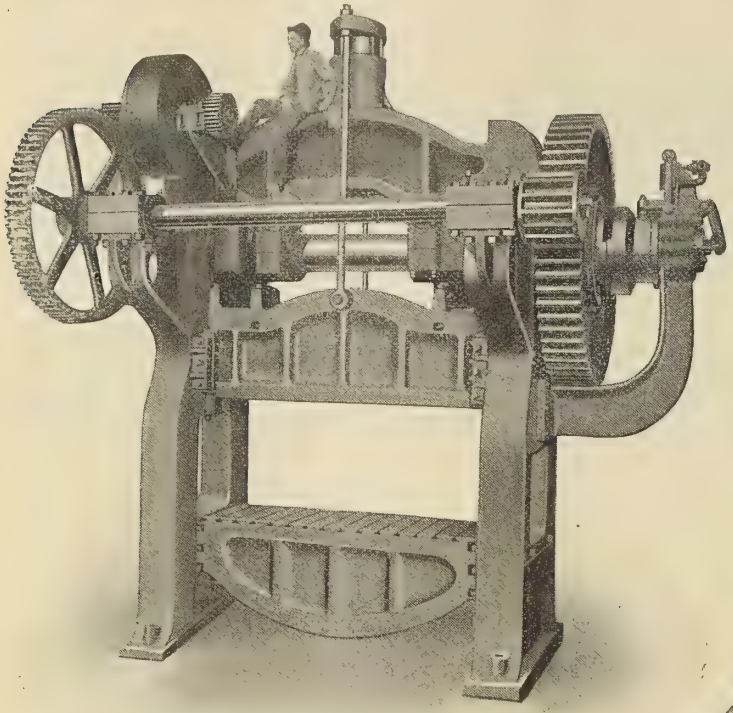


Fig. 1.—Covington Multiple Punch

Covington Punches

The Covington Machine Company, Covington, Va., has on the market a special line of tools for shipyard work, including punches, shears, bending rolls and plate planers.

Fig. 1 shows a large multiple punch located at the plant of the Pressed Steel Car Company, McKees Rock, Pa. This machine was designed for punching, among other operations, four sides of what is known as the "bath tub bolster" at one stroke. Its capacity is sixty 13/16-inch holes and one 2½-inch hole through ¾-inch mild steel plate at a single stroke. The dies and holders are not shown in this photograph, but are fastened to the head and bedplate, respectively. The weight of this machine is 185,000 pounds; the main frames and bolsters are of steel castings, and the width between housings is 122 inches. By the use of modern spacing tables, which the Covington Company furnishes, a multiple punch of less size than the one illustrated can be made to produce large returns for punching flat sheets. The end rows of holes are all punched at one stroke, the girth seam holes being punched on both sides at once. A spacing table can be arranged to punch approximately rectangular sheets so that slightly conical sections can be automatically punched. The advantages of such an arrangement for shipyards handling a large amount of work are obvious.

In Figs. 2 and 3 are shown the application of universal jaws on punches, an arrangement which is not fully appreciated by many shipbuilders. While this form of jaw is not recommended for machines that are to be used almost exclusively for shearing work, nevertheless in small shops, where a wide range of duty is desired from a single tool, the construction is very desirable, as flanges and channels and deep angle irons can be punched with ease, and at the same time shear blades can be attached if desired. In larger shops the universal jaw for a punch would be applicable in many cases.

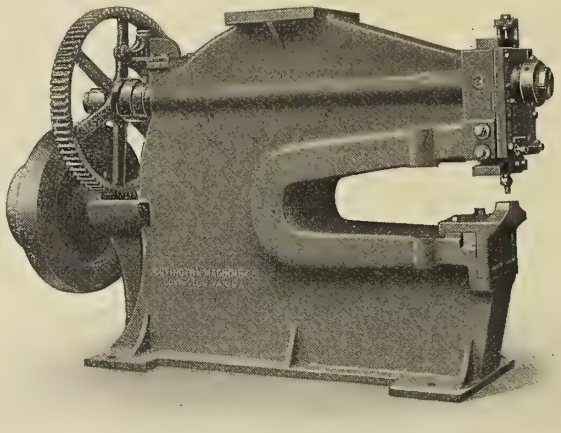


Fig. 2.—Universal Jaw—Punch

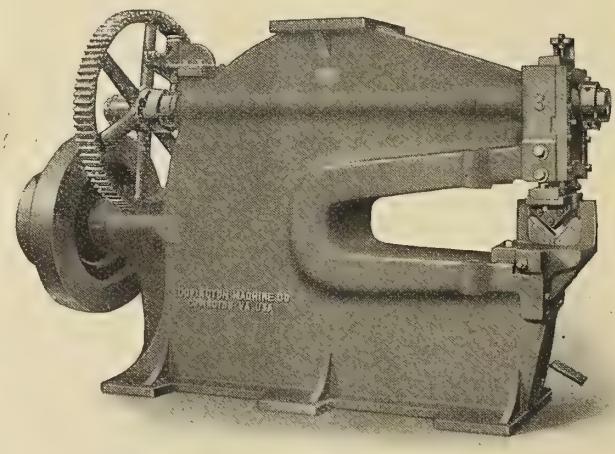


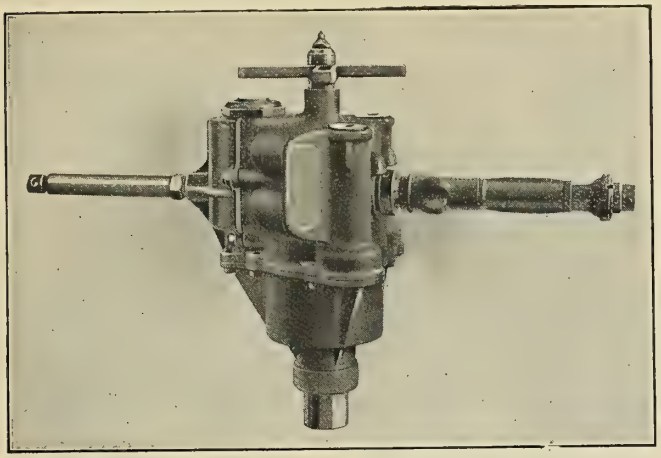
Fig. 3.—Universal Jaw—Angle Shear

Portable Pneumatic Drill for Exceptionally Heavy Work

The "Little David" line of pneumatic drills, manufactured by the Ingersoll-Rand Company, New York, has been increased by the addition of an exceptionally powerful compound geared model, No. 11 SE. This drill is reversible and is adapted to the heaviest flue rolling, drilling, reaming and tapping. It is particularly recommended by the manufacturer for tapping on flexible staybolt work, running in staybolt sleeves, engine valve setting and kindred heavy-duty operations. It is so constructed that it develops full power on the reverse as well as the forward motion. This is pointed out to be of particular advantage in that, after running a flexible staybolt sleeve up tight, the No. 11 SE, due to its unusual power on the reverse motion, will unscrew the sleeve cap. This obviates the necessity for the usual cumbersome wrench.

This drill has the one-piece, gear-timed valves and ball

and roller-bearing crankshaft and connecting rods and general simplicity of construction, which have been features of the pneumatic drills of this manufacturer. It



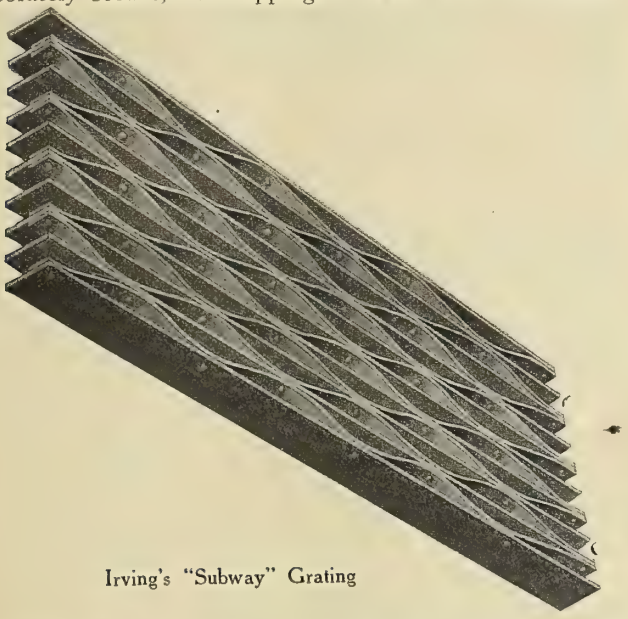
"Little David" Drill for Heavy Work

is ordinarily furnished with a No. 5 Morse taper socket. It operates at a free spindle speed of 100 revolutions per minute.

Irving's "Subway" Gratings for Engine-Room Platforms

The metal grating illustrated, which is manufactured by the Irving Iron Works Company, Long Island City, N. Y., and which was patented on November 26, 1912, under the trade name of "Irving's Subway Grating," is especially adapted for engine-room platforms and other places on board ship where gratings are desirable.

The form of construction, it is claimed, provides an absolutely secure, non-slipping foothold and a maximum



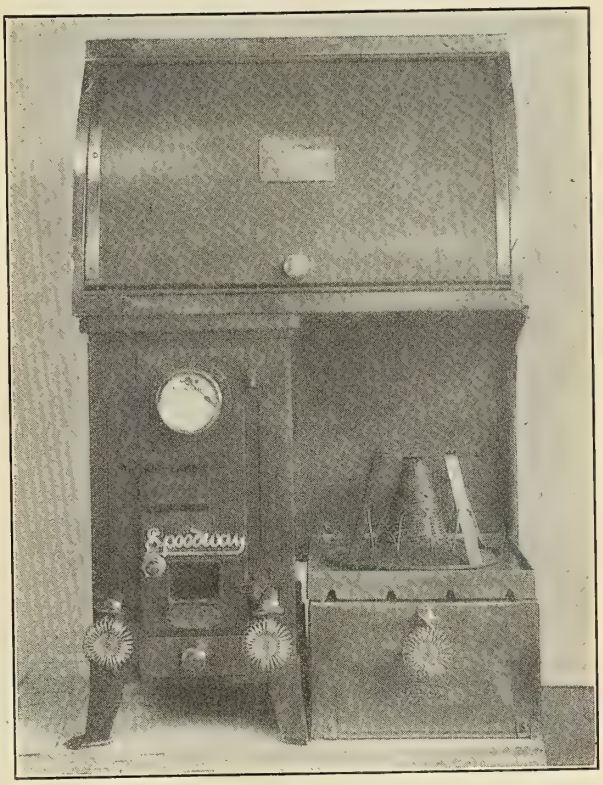
Irving's "Subway" Grating

of ventilation and light. Trucks can be wheeled across the grating in any direction without the danger of the wheels going through and spreading the bars. The truss element of construction makes for extreme rigidity and the full distribution of all loads. Ordinary holes for pipes, vents, etc., can be cut out without additional framing, as the loads will be transmitted around the opening.

This type of grating affords an excellent stair tread, being light, clean and absolutely non-slipping under all conditions. The advantages claimed for it are that it is stronger, smoother and less heavy than checkered steel, cast iron or other ordinary types of metal grating of equivalent strength.

Speedway Alcohol Stove for Yachtsmen

The Gas Engine & Power Company and Chas. L. Seabury & Company, Consolidated, Morris Heights, N. Y., has placed on the market a new type of alcohol stove known as the "Speedway," which involves many improvements. The alcohol burner has been produced in two types—a single and a double burner. The so-called wick is made of such construction as to completely gasify the liquid alcohol before it reaches the burner tips. All burners are so constructed that they can be cleaned from the front of the stove. Leaks through the valve stem opening are effectively prevented by a packing nut with lock nuts. A flash



Speedway Alcohol Stove

pan is so designed that should a valve be left open through carelessness the fuel will not run over and gasify in the compartment, but will pass through an overflow pipe and drain into an auxiliary tank placed conveniently below the stove itself. In this way not only is the overflow alcohol prevented from doing damage, but it is actually saved and poured back into the fuel tank to be used.

This stove has a new type of broiler consisting of a vertical box-like device in which are installed two "Speedway" especially designed burners—one on each side near the bottom. Over these burners are suspended baffle plates so that the heat is uniformly distributed from the bottom to the top of the broiler. On the bottom between the two burners is a drain trough in which the broiling iron is placed in a vertical position. A temperature of 300 to 350 degrees indicated on a thermometer on the door assures a good, quick broiling temperature of 450 to 500 degrees inside. The grease from the broiling meat is drained through a grease drawer beneath the broiler, from which it is recovered without burning and filling the compartment with odors and smoke.

Bernstein Metal Berths

The metal berth illustrated, which is manufactured by the Bernstein Manufacturing Company, Philadelphia, Pa., is of the stationary type for steerage and crew quarters. The stanchions which support the berth are of 1⅜-inch steel tubing equipped with deck flanges or Bernstein flush sockets. Adjustable top flanges, which allow for variation in the height between decks, are also provided, together with malleable iron sockets forming a support for the berth frame. Where necessary cast iron bulkhead brackets are provided in place of the stanchions.

The sides of the berth frames are of 1⅜-inch steel tubing, the ends 1⅛-inch chilled-jointed construction, and

Bernstein Steerage and Crew Berths

the lee rails of 1⅛-inch steel tubing, also chilled-jointed to the frame. The head and foot rails are of ½-inch round iron chilled-jointed to the ends of the berth, and the frame is fitted with National link springs.

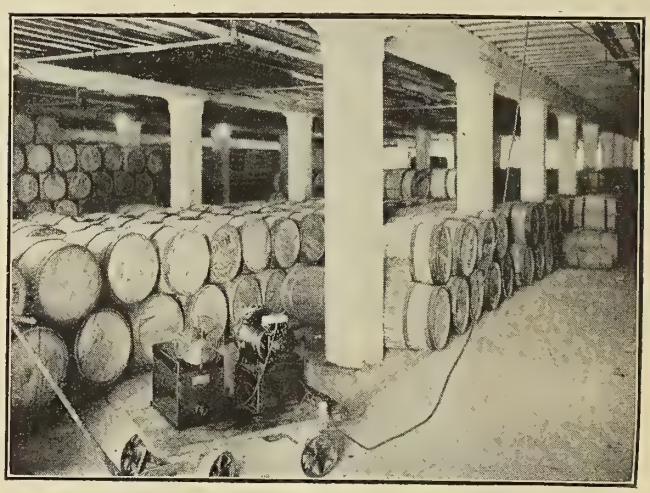
The berth is held in place by flat head steel pins, chilled-jointed to the frame and rests in malleable iron stanchion sockets. The standard size berth is 2 feet 3 inches by 6 feet 3 inches. It is finished regularly in aluminium bronze, but can be finished in any desired color.

In addition to the berth illustrated, the Bernstein Manufacturing Company supplies a complete line of steel equipment for furnishing ships, including folding and stateroom berths, stateroom beds, metal lockers, cabinets and metal furniture.

Sprague Electric Ozonators for Cold Storage Spaces

The difficulties of eliminating odors and the prevention of cross tainting in cold storage spaces for perishable foodstuffs have been accomplished, it is claimed, by the use of ozone properly applied to the atmosphere of the cold storage room. Ozone is simply the oxygen of the air changed into a highly active state by the action of the electric current in an ozonator. In this form it has the remarkable power of destroying by oxidation or burning up the odor-bearing particles of matter floating in the air. This results in the permanent removal of the odor without the necessity of introducing chemicals of any kind.

The Sprague electric ozonator, manufactured by the Sprague Electric Works of the General Electric Company, New York, consists of a small metal box containing the ozone generating tubes and surmounted by an electric fan which forces air through the ozonator and insures an efficient distribution of the ozone. The ozone is formed from the air as it is blown through the electric discharge maintained in the ozone generating tubes. The amount of electricity consumed is equivalent to only about two 40-watt tungsten lamps, and the machines are built for operation on 110-volt alternating current of either 60 or 25-cycle frequency. Where direct current only is available, a small motor generator is supplied to furnish the



Sprague Ozonator in Operation

necessary alternating current for the operation of the machine.

The principal use of these machines is in the deodorization of storage rooms after they have been emptied of their contents in order to prepare them for the reception of other products. With these machines a thorough deodorization of a storage room is accomplished, it is claimed, in about two or three hours.

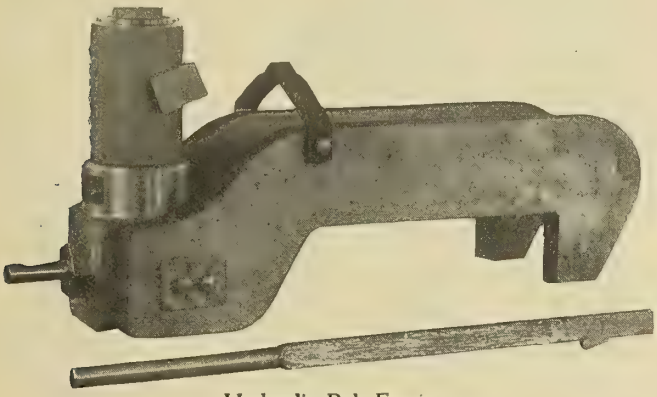
40-Ton Hydraulic Bolt Forcer

The machine illustrated is a small but powerful hydraulic tool designed by the Hydraulic Press Manufacturing Company, Mount Gilead, Ohio, for use in forcing in or out the coupling bolts on steamship shafts where the working space is limited and also for other miscellaneous forcing work which comes up in a navy or shipbuilding yard. The tool's lightness and compactness permit its transportation to the work wherever it may be located. If the work is in an elevated position the forcer can be raised by a small hoist or crane to the work and readily adjusted for the forcing operation. If the work is of such nature that the hook resistance bars are not suitable they may be changed to suit the peculiar requirements for which this forcer is to be used.

The principle by which the pressure is exerted on the ram is the same as that of the hydraulic jack. A maximum total pressure capacity of 40 tons is transmitted on the ram with very little effort on the part of the operator. A rapping pin is provided through the rear of the horizontal cylinder, so that if the bolt does not start with the maximum pressure of the tool a jar may be given on the bolt by a blow on the pin.

The pump and valves are encased in the vertical pump body. The working parts are not exposed. The pump body forms the water or fluid reservoir and the pump

plunger works through the center of this reservoir. The pressure is released from the ram by turning the pump handle over so that the lug on the pump body does not come in contact with the lug on the handle. This permits the pump handle to be forced to a lower position, which



Hydraulic Bolt Forcer

causes a flange on the pump plunger to have a bearing on the discharge check valve stem, thus opening it and permitting the fluid to return to the reservoir.

The ram is soft steel with a hard steel facing, having a travel of 3 inches. The height from the top of the pump body to the base is 19 inches. The distance from the rapping pin to the outer edge of the resistance hooks is 43 inches; from the edge of the resistance hooks to the end of the cylinder the distance is 38¾ inches. The working space between the forcer ram and the face of the hooks is 19 inches.

PERSONAL MENTION

John Carey has been appointed first assistant engineer of the steamer *Adirondack,* of the Hudson Navigation Company, New York.

Webb Cooley, first assistant engineer of the United States tug *General Totten,* has been promoted to the posi- of chief engineer of this tug.

Hermann Winter, assistant to the general agent for the Cunard Steamship Company in the United States, has severed his connection with that company.

William C. Claflin, formerly chief engineer of the steamer *Mary Garden,* has been appointed engineer of the tug *Florence W.,* engaged on barge canal work at Mechanicsville, N. Y.

John Daly, formerly chief engineer of the United States tug *General Totten,* has resigned to accept the position of first assistant engineer on the towing steamer *M. A. Knapp* at Troy, N. Y.

H. Keil, formerly naval architect and technical adviser of the Seattle Construction & Dry Dock Company, Seattle, Wash., is naval architect of the Skinner & Eddy Shipbuilding Company, Seattle, Wash.

G. C. Dohm, draftsman in the scientific department at the New York navy yard, has been appointed assistant naval architect in the scientific department of the Skinner & Eddy Shipbuilding Company, Seattle, Wash.

G. L. Kothny, formerly consulting engineer with the Westinghouse Machine Company, East Pittsburg, Pa., has been appointed consulting engineer and manager of the marine department of the C. H. Wheeler Manufacturing Company, Philadelphia, Pa.

A. C. Brown, vice-president and assistant manager of the Brown Hoisting Machinery Company, Cleveland, Ohio, has been elected general manager of the company, succeeding R. B. Sheridan, who has resigned to accept a position with the American International Corporation, New York City.

OBITUARY

James A. Allan, formerly one of the chief partners of the Allan Steamship Line, died on April 17, at Glasgow, Scotland.

James M. Lincoln, an engineer in the service of the Clyde Steamship Line, died recently at Wareham, Mass., at the age of sixty-two.

Captain William Jamieson, one of the oldest captains on the Great Lakes, died recently at his home in Milwaukee, Wis., at the age of eighty-five years.

Erasmus D. Leavitt, a graduate of the Naval Academy and a prominent mechanical engineer, died at Cambridge, Mass., on March 11, aged seventy-nine years.

Thomas Ward, a veteran marine engineer of Albany, N. Y., died recently, after a lingering attack of muscular rheumatism. Mr. Ward owned and operated several tugs at Albany and Troy, N. Y.

Peter Deitz, a popular engineer at Albany, N. Y., died recently at St. Peter's hospital, Albany, of Bright's disease. For several years Mr. Deitz was in the employ of the Davis Construction Company, Albany, N. Y.

Robert McCreery, head of the harbor lighterage business under the firm name of John McCreery's Son, and a member of the Steamship Board of Navigation, died recently at his home in New York City, aged sixty-four years.

Edward J. Garvey, a veteran marine engineer, died at his home in Watervliet, N. Y., on March 20. Up to the time of his retirement Mr. Garvey had been employed on the ferries at Troy, N. Y., and was formerly employed on harbor craft in New York harbor.

Captain Worth G. Ross, who retired as chief of the United States Revenue Cutter Service in 1911, died at his home in New Bedford, Mass., on March 24 at the age of sixty-two. Captain Ross became chief of the Revenue Cutter Service in 1905 and held this position until his retirement on account of ill health in 1911.

Darwin Almy, president of the Almy Water Tube Boiler Company, Providence, R. I., died recently at his home in Providence. Mr. Almy's successor as president of the company is Frank D. Almy, for many years superintendent of the company. Charles F. H. Almy is vice-president and secretary of the company, and Walter S. Almy, treasurer.

Joseph A. Sedgwick, treasurer of the Fore River Shipbuilding Corporation, Quincy, Mass., died at his home in Quincy on April 14, aged forty-five years. Mr. Sedgwick was formerly employed in the purchasing department of the Bureau of Construction and Repair of the Navy Department and became associated with the Fore River Shipbuilding Company in 1904 as auditor of the company.

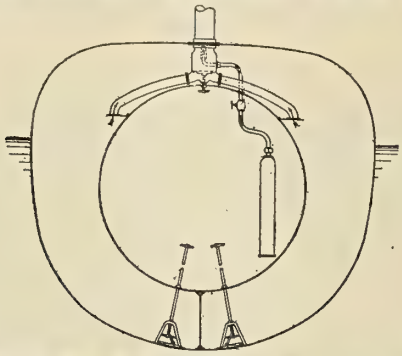
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,161,484. SUBMARINE VESSEL. CESARE LAURENTI, OF TURIN, ITALY, ASSIGNOR TO SOCIETÀ FIAT-SAN GIORGIO, OF SPEZIA, ITALY.

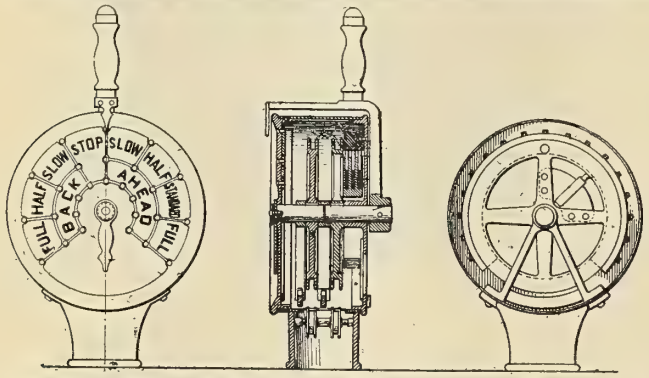
Claim.—In a submarine, ballast tanks, pipes leading from the ballast tanks for the escape of air therefrom when it is desired to admit water for submergence purposes, and an injector located in the air escape pipe



for accelerating the flow of air from said ballast tanks and thereby accelerating the inflow of water and the submergence of such vessel.

1,163,191. SHIP'S TELEGRAPH. FRANK W. WOOD, OF BROOKLYN, N. Y., AND HARRIS LANING, OF PETERSBURG, ILL.; SAID WOOD ASSIGNOR, BY MESNE ASSIGNMENTS, TO CHARLES CORY & SON, INC., OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

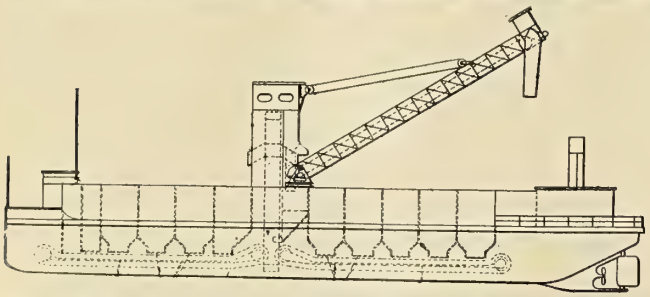
Claim 1.—In an apparatus, the combination of mechanical transmitting signal means having a chain, an electrical transmitting signal means having a plurality of fixed independent electrical contact terminals, and



a fixed common terminal, of a shaft, a pulley keyed on said shaft adapted to receive said chain whereby to actuate said mechanical transmitting means, a plurality of contact fingers mounted on said pulley and rotatable therewith and adapted to engage said fixed terminals, one of said contact fingers being adapted to engage with said common terminal, and a handle on said shaft for turning the same and the pulley whereby to positively actuate both of said signal means simultaneously. Two claims.

1,164,934. FUEL LIGHTER. RAYMOND W. DULL, OF AURORA, ILL., ASSIGNOR TO STEPHENS-ADAMSON MFG. CO., OF AURORA, ILL., A CORPORATION OF ILLINOIS.

Claim 1.—A boat divided into compartments forming bins, conveyors for receiving the contents of the bins, means for controlling the dis-



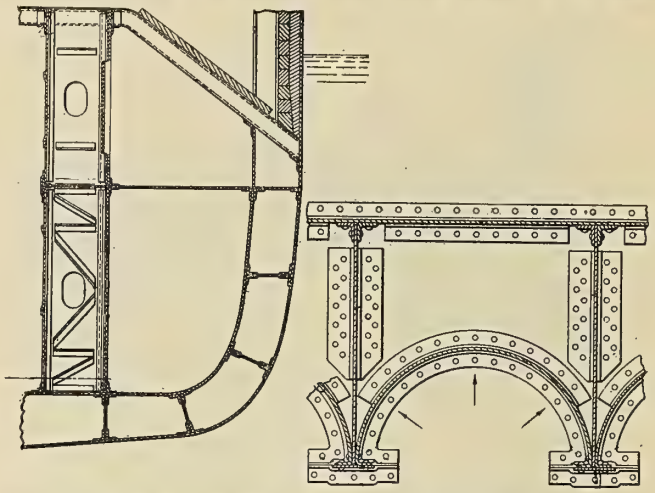
charge of the contents from the bins, an elevator for receiving the contents from the conveyors, the ends of the conveyors overhanging the transversely arranged lower portion of the elevator, a boom provided with a conveyor for receiving the contents from the elevator, and a spout for the end of said boom, whereby the contents of any bin can be discharged at either side of the boat. Six claims.

1,162,132. DAVIT. JOHN CAMERON, OF NEWARK, N. J.

Claim 3.—A davit comprising vertically arranged rotatable davit arms, supporting means for said arms, locking means on the arms for engaging the supporting means to lock the arms in predetermined positions, and means on said support to engage the locking means to automatically cause the locking means to assume a locking position. Sixteen claims.

1,164,814. ELASTIC BULKHEAD. WILLIAM HOVGAARD, OF BROOKLINE, MASS.

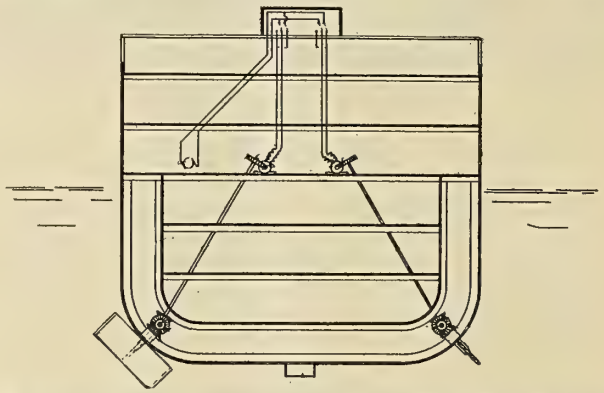
Claim 1.—A bulkhead embodying in its construction a series of fixed supports, a wall of substantially plane plating secured to the inner



faces of said series of supports, and a second wall of plating secured to the outer edges of said series of supports, said second wall being curved inwardly intermediate said supports. Five claims.

1,164,817. SHIP BRAKE. JOHN H. HYDE, OF TACOMA, WASH.

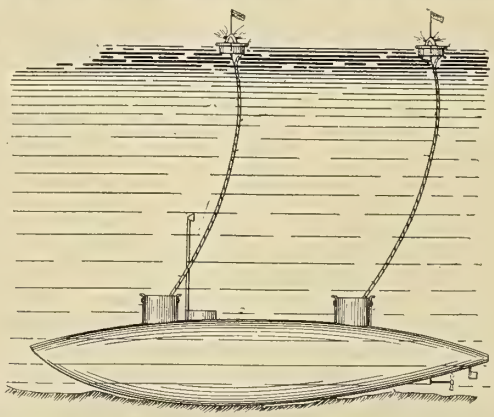
Claim.—The combination in a ship of a series of longitudinally extending bilge keels of box construction fixedly secured to the ship in coaxial arrangement and having free spaces therebetween, correspond-



ingly shaped brake plates mounted in said free spaces, said brake plates being of the full thickness of said keels, pivots secured to said brake plates at their longitudinal centers and passing through the skin of the ship, and positive means for turning said brake plates arranged to move the same at right angles to said keels when so desired.

1,169,128. APPLIANCE FOR VESSELS. EDWARD F. CRANE, OF HOBOKEN, N. J., ASSIGNOR OF ONE-HALF TO ARTHUR J. GRYMES, OF EAST ORANGE, N. J.

Claim 1.—The combination with a vessel, a container mounted on its hull, the bottom of the container and the hull having registering openings with packing therein, a cable having its lower end secured in the



hull and its body passing through one of said openings and stored within the container, and a tubing stored within the hull and its body passing through the other of said openings; of buoy normally closing the upper end of the container, the upper end of the cable being attached to said buoy and the upper end of the tubing passing through said buoy, and means within the vessel for releasing the buoy from the container. Five claims.